California Air Resources Board

Greenhouse Gas Quantification Methodology for the Strategic Growth Council Affordable Housing and Sustainable Communities Program

Greenhouse Gas Reduction Fund
Fiscal Year 2016-17

Note:
The California Air Resources Board (ARB) is accepting public comments on the Draft Fiscal Year (FY) 2016-17 Affordable Housing and Sustainable Communities (AHSC) Program Greenhouse Gas (GHG) quantification methodology and Draft AHSC GHG Calculator tool until **April 14, 2017** via email at GGRFProgram@arb.ca.gov. This Draft GHG quantification methodology and accompanying Draft AHSC GHG Calculator tool are subject to change pending stakeholder comments and final AHSC Program Guidelines for FY 2016-17. The final GHG quantification methodology and accompanying AHSC GHG Calculator tool are expected to be released in coordination with final FY 2016-17 AHSC Program materials and will be available on the ARB Quantification website www.arb.ca.gov/cci-quantification.

DRAFT
March 8, 2017

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Updates

The Air Resources Board (ARB) updated the Fiscal Year (FY) 2015-16 quantification methodology to enhance the analysis and provide additional clarity to project applicants. A summary of the updates to the quantification methodology is presented by section in the tables below. The accompanying Affordable Housing and Sustainable Communities (AHSC) Greenhouse Gas (GHG) Calculator tool was updated as necessary to reflect updates to the quantification methodology.

For more information, a detailed list of the updates can be found on page 6 of this quantification methodology. Additionally, a commented, track-change version of the updates to the FY 2015-16 quantification methodology is available on the ARB quantification materials webpage at: www.arb.ca.gov/cci-quantification.

General (all sections)

Item Updated	Description of Update
Revised	
ARB FY 2016-17 Quantification Methodology Template	Updated the format of the quantification methodology to the FY 2016-17 template for consistency with other Greenhouse Gas Reduction Fund (GGRF) Program quantification methodologies

Section B. CalEEMod

Item Updated	Description of Update
Revised	
CalEEMod 2016	Updated methodology to use most recent CalEEMod (2016 from 2013)
Increase Density	Increased the housing development density (i.e., dwelling units per acre) to match the minimum AHSC Guidelines requirements
Limit Parking Supply	Capped maximum potential vehicle miles traveled reductions by limiting project specific data input to CalEEMod to 25 percent per the CAPCOA Quantification Report
Improve Destination Accessibility	Relocated from additional benefits to CalEEMod since the measure was corrected in the updated CalEEMod (2016)
Transit Improvement Measures	Relocated to TAC Methods to align with GGRF Program quantification methodologies to estimate GHG emission reductions from transit-related projects
Removed	
Increased Transit Accessibility	Removed because increased transit accessibility is a threshold requirement of the AHSC Guidelines
Improve Walkability Design	Removed to prevent duplicative scoring to the walkability index (as seen in the scoring criteria of the AHSC Guidelines)

Commute Measures	Removed because these measures apply to employees and are implemented by employers of commercial land use types, which may not be known at the time of the application
Integrated Connectivity Projects / Rural Innovation Project Areas Adjustment	This adjustment is removed concurrent with the removal of the increased transit accessibility; all projects must be within a half-mile of transit per the AHSC Guidelines

Section C. TAC Methods

Item Updated	Description of Update
Revised	
Pedestrian Facility Calculation	Method for calculating GHG emission reductions updated to match the method for a bike facility
Emission Factors	Updated using EMFAC 2014 to derive fuel consumption rates
Added	
Additional Active Transportation Measures	Class 4 Bikeways and Bike Share project types added as quantifiable active transportation measures per AHSC Guidelines and to align with GGRF Program quantification methodologies
Additional Transportation Measure	Capital improvements that encourage mode-shift project type added as a quantifiable transportation measure in accordance with AHSC Guidelines (e.g., new transit facilities that connect to bike or pedestrian paths)

NOTE: Parking is an in-eligible AHSC Program cost; however, parking measures continue to be allowable in the quantification methodology because of benefits associated with parking reduction. Additionally, the designation of “retirement community” will continue to be used for senior housing projects designation.

Table of Contents

Section A. Introduction

The goal of California Climate Investments is to reduce greenhouse gas (GHG) emissions and further the purposes of the Global Warming Solutions Act of 2006, known as Assembly Bill (AB) 32. The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate the GHG emission reductions and other benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). ARB develops these methodologies based on the project types eligible for funding by each administering agency as reflected in the program Expenditure Records available at: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/expenditurerecords.htm. ARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified.

For the Strategic Growth Council's (SGC) Affordable Housing and Sustainable Communities (AHSC) Program, ARB staff developed this quantification methodology and AHSC GHG Calculator tool to provide methods for estimating GHG emission reductions of each proposed project (Section B and C), provide instructions for documenting and supporting the estimate (Section D), and outline the process for tracking and reporting GHG emission reductions and other benefits once a project is funded (Section E).

This methodology uses tools to estimate the change in vehicle miles traveled (VMT) and associated GHG emission reductions based on specific land use and transportation characteristics of AHSC projects. These tools consist of components of the "California Emissions Estimator Model" (CalEEMod) version 2016.3.1 and calculation methodologies based on the "Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects" (CMAQ Methods).

The CMAQ Methods were used as the basis for developing the GHG reduction estimates for certain project features that are not captured in CalEEMod, specifically transit and connectivity (TAC) features. The CMAQ Methods document can be downloaded from http://www.arb.ca.gov/. However, all of the equations and assumptions needed for this quantification method are included in this document and some assumptions have been modified as necessary. Therefore, the equations used in this quantification methodology are referred to as TAC Methods. Projects will report the total project GHG emission reductions estimated using this methodology as well as the total project GHG emission reductions per dollar of GGRF funds requested.

AHSC Project Types

The AHSC Program will reduce GHG emissions through projects that implement land use, housing, and transportation strategies to support infill, compact, and affordable housing development projects. The AHSC Program identifies three project types: Transit Oriented Development (TOD), Integrated Connectivity Projects (ICP), and Rural Innovation Project Areas (RIPA). For GHG quantification purposes, projects that include affordable housing or housing related infrastructure will primarily use CalEEMod. Projects without a housing-related component will use the methodologies from the TAC Methods.

Table 1 lists the most common project types SGC expects to receive in the AHSC Program and identifies which quantification method would likely be used to estimate GHG emission reductions. For some projects, it may be appropriate to use both methods. Appendix A includes an example project that uses both methods.

Table 1. Example Project Features and Quantification Method(s)

AHSC Project Features	CalEEMod	TAC Methods
Affordable housing (including affordable housing developments, housing-related infrastructure, and substantial rehabilitation of housing)	X	
Mixed use development	X	
Regional transit projects (e.g., new bus service, vanpools) not associated with housing or other land use development components		X
Sustainable Transportation Infrastructure (e.g., bicycle paths, bike lanes, bikeways, pedestrian facilities) that encourages mode-shift		X
Transportation-Related Amenities (e.g., bus shelters, benches, etc.) that encourage mode-shift		X
Affordable housing AND regional transit project	X	X

Figure 1 below outlines the process for calculating the GHG emission reductions for the proposed project.

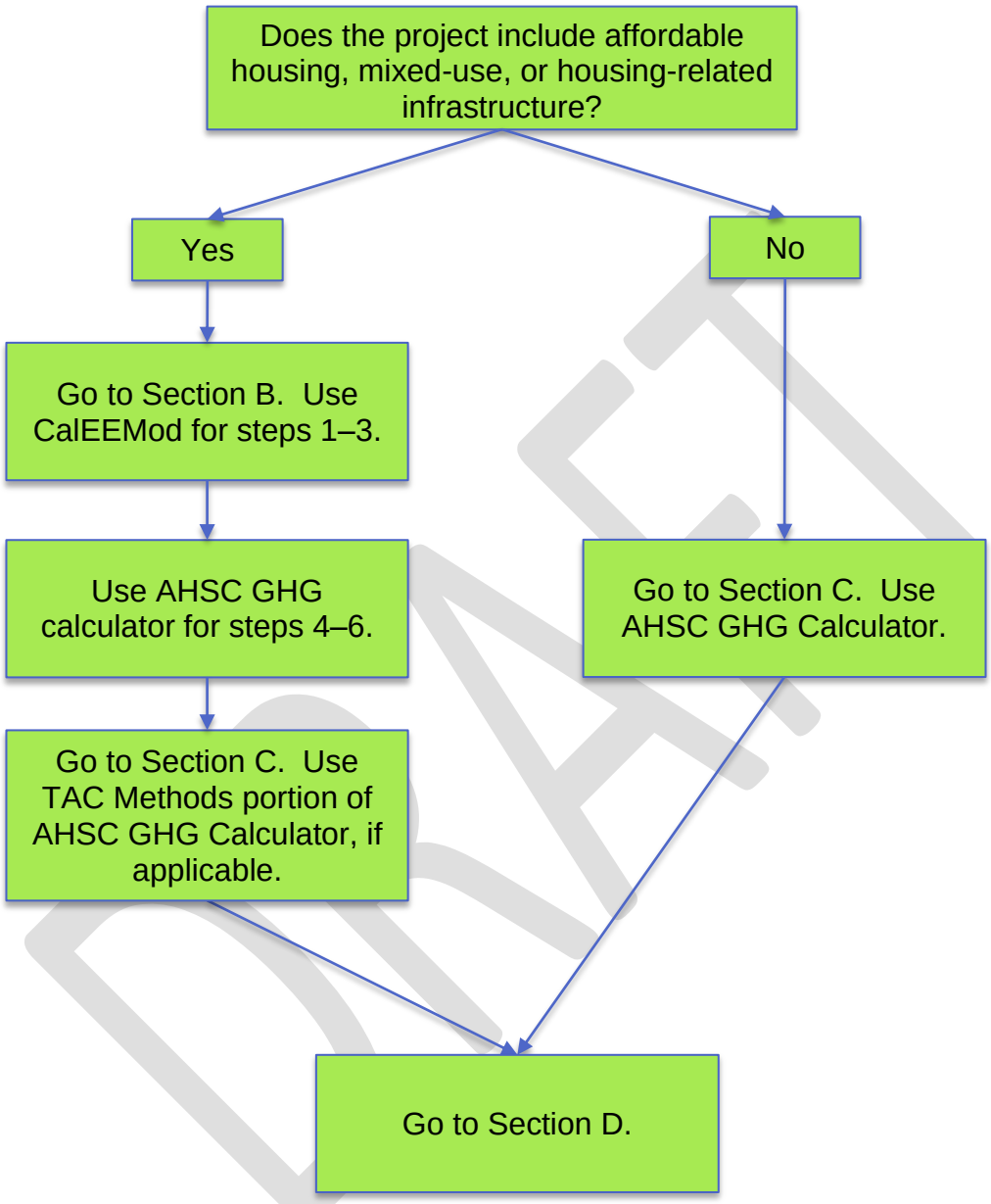


Figure 1. Quantification Methodology Flow Chart

Methodology Development

ARB and SGC developed this quantification methodology consistent with the guiding implementation principles of California Climate Investments, including ensuring transparency and accountability.[i] ARB and SGC developed this quantification methodology through a public process to be used to estimate the outcomes of proposed projects, inform project selection, and track results of funded projects. The implementing principles ensure that the methodology would:

- Apply at the project-level;
- Provide uniform methods to be applied statewide, and be accessible by all applicants;
- Use existing and proven tools and methods;
- Use project-level data, where available and appropriate; and
- Estimate GHG emission reductions from a discrete list of VMT reduction measures.
- Reflect relationships between VMT and GHG reductions that are supported by empirical literature.

ARB reviewed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for AHSC project types. ARB also consulted with SGC to determine project-level inputs available. The methods were developed to provide estimates that are as accurate as possible with data readily available at the project level.

Applicants must use this quantification methodology, in conjunction with the accompanying AHSC GHG Calculator tool, to estimate the GHG emission reductions of the proposed project. The AHSC GHG Calculator tool can be downloaded from: www.arb.ca.gov/cci-quantification.

In addition, SGC held three public “Lessons Learned” workshops in December 2016 to discuss issues faced by applicants in the FY 2015-16 AHSC application and selection process. ARB attended the workshops to listen to issues specific to the quantification methodology. The input from applicants at the Lessons Learned workshops helped to inform the updates in this quantification methodology.

Tools

This quantification methodology and the AHSC GHG Calculator tool rely on project-specific outputs from the following tools:

CalEEMod is a "state-of-the-practice" land use emissions calculator tool designed to quantify GHG emissions and criteria air pollutants associated with land use development projects, including transit-oriented developments and mixed-used developments. CalEEMod is used statewide by lead agencies to evaluate the GHG emissions and criteria air pollutants of land use development projects pursuant to the California Environmental Quality Act (CEQA), the National Environmental Protection Act (NEPA), and for compliance with local air quality rules and regulations. CalEEMod includes a suite of mitigation measures so that a user may compare a mitigated project's emissions to an unmitigated project's emissions. The GHG emission reduction impacts of the mitigation measures were developed by and are detailed in a study conducted by the California Air Pollution Control Officers Association (CAPCOA) titled "Quantifying Greenhouse Gas Mitigation Measures" (CAPCOA Quantification Report)[ii]. The CAPCOA Quantification Report includes detailed fact sheets that describe the underlying research and the data used to develop the reduction impacts (also called effects or elasticities) and provide project level examples for each measure. The CalEEMod tool, User's Guide, and other supporting documents can be downloaded from www.caleemod.com.

The CMAQ Methods are a set of equations for evaluating the cost-effectiveness of certain types of transportation projects, including bicycle paths, vanpools, and new bus service. The CMAQ Methods were developed by ARB and the California Department of Transportation and are used statewide by transportation agencies to evaluate criteria pollutant emission reductions from transportation projects competing for State motor vehicle fee and federal CMAQ funding.

CalEEMod and the CMAQ Methods are used statewide, are publicly available, and are subject to regular updates to incorporate new information. The tools and documentation are free of charge and available to anyone with internet access. Both methods require land use characteristics and VMT reduction features from the proposed project, which should be readily available in the project application.

Updates

ARB updated this quantification methodology to enhance the analysis and provide additional clarity to project applicants. The changes made are lists below by section.

General

- Updated format of the quantification methodology to match the FY 2016-17 quantification methodology template
- Parking is an in-eligible AHSC Program cost; however, parking measures continue to be allowable in the quantification methodology because of benefits associated with parking reduction
- The designation of "retirement community" will continue to be used for senior housing projects designation

A. Introduction

- Revised Table 1 to closer align with AHSC project types
- Updated the Updates sub-section to indicate changes made to the quantification methodology and calculator tool

B. GHG Quantification Methodology Using CalEEMod

- Updated the methodology to use CalEEMod 2016[1] from CalEEMod 2013
    - The trip rates from Institute of Transportation Engineers (ITE) 9th edition of the Trip Generation Manual were incorporated
    - The regional default data provided by the air districts/local Metropolitan Planning Organizations (MPO) (e.g., architectural coating ROG content limits, percentage of wastewater treatment (septic tanks/aerobic/anaerobic), MPO trip rate information, number of snow days vs. summer days waste treatment plant specific effluent nitrogen, etc.) has been incorporated
    - The calculation methodologies for GHG mitigation measures LUT-1, LUT-4, LUT-6, LUT- 9, and WSW-1 have been corrected. Also, the model has been revised so that the mitigation measures, when applied, will recognize when the user changes the defaults.
- Updated screen shots from CalEEMod 2016
- Revised the equation for calculating LUT-1 in the "Additional Benefits" section of the AHSC GHG Calculator tool to adjust the baseline density to be consistent with the minimum required dwelling units per acre in the AHSC Guidelines for the applicable project setting (see Table E-1 for minimum requirements);
- Updated PDT-1 to cap maximum potential VMT reductions at 12.5 percent by limiting project specific input to CalEEMod to 25 percent per CAPCOA Quantification Report
- Removed LUT-5 and ICP/RIPA Adjustment as all projects must be within a half-mile of transit per AHSC Guidelines

[1] For a list of updates to CalEEMod see: http://www.aqmd.gov/docs/default-source/caleemod/completelistofchanges.pdf

- Removed LUT-9 to prevent duplicative scoring to the walkability index; this measure will be scored using the walkability index as seen in the scoring criteria of the AHSC Guidelines
- Removed Commute Measures since these apply to employees and implemented by employers of commercial land use types which may not be known at time of application
- Relocated LUT-4 from additional benefits to CalEEMod
- Relocated Transit Improvement Measures to TAC methods

C. GHG Quantification Methodology Using TAC Methods

- Updated language to clarify the different active transportation measure types
- Updated method for calculating GHG emission reductions for pedestrian facilities to match the method for calculating GHG emission reduction for bike facilities
- Added Class 4 Bikeways and Bike Share project types as quantifiable active transportation measures
- Added Capital Improvements that encourage mode-shift project type as a quantifiable transportation measure

Appendix A

- Updated example to match updates

Appendix E

- Included Capital Improvements
- Updated Method to match updates in Section C
- Updated Train Emission Factor Table

Appendix F

- Added new appendix with emission factor explanation (*to align with all GGRF Programs*)
- Updated the GHG emission factors used to estimate reductions
- Used EMFAC 2014 to derive fuel consumption rates

Calculator Tool

- Updated the AHSC GHG Calculator tool as necessary to reflect changes in the quantification methodology

Note: A commented**,** track**-**change version of this document is available on the ARB quantification materials webpage at: www.arb.ca.gov/cci-quantification.

Program Assistance

ARB staff will review the quantification portions of the AHSC project applications to ensure that the methods described in this document were properly applied to estimate the GHG emission reductions for the proposed project. Applicants should use the following resources for additional questions and comments:

- Applicants are encouraged to check the frequently asked questions (FAQ) page regularly during the application process, which is at: www.arb.ca.gov/cci-quantification.
- Questions on this document should be sent to GGRFProgram@arb.ca.gov.
- For more information on ARB's efforts to support implementation of GGRF investments, see: www.arb.ca.gov/auctionproceeds.
- Questions pertaining to the AHSC Program should be sent to ahsc@sgc.ca.gov.

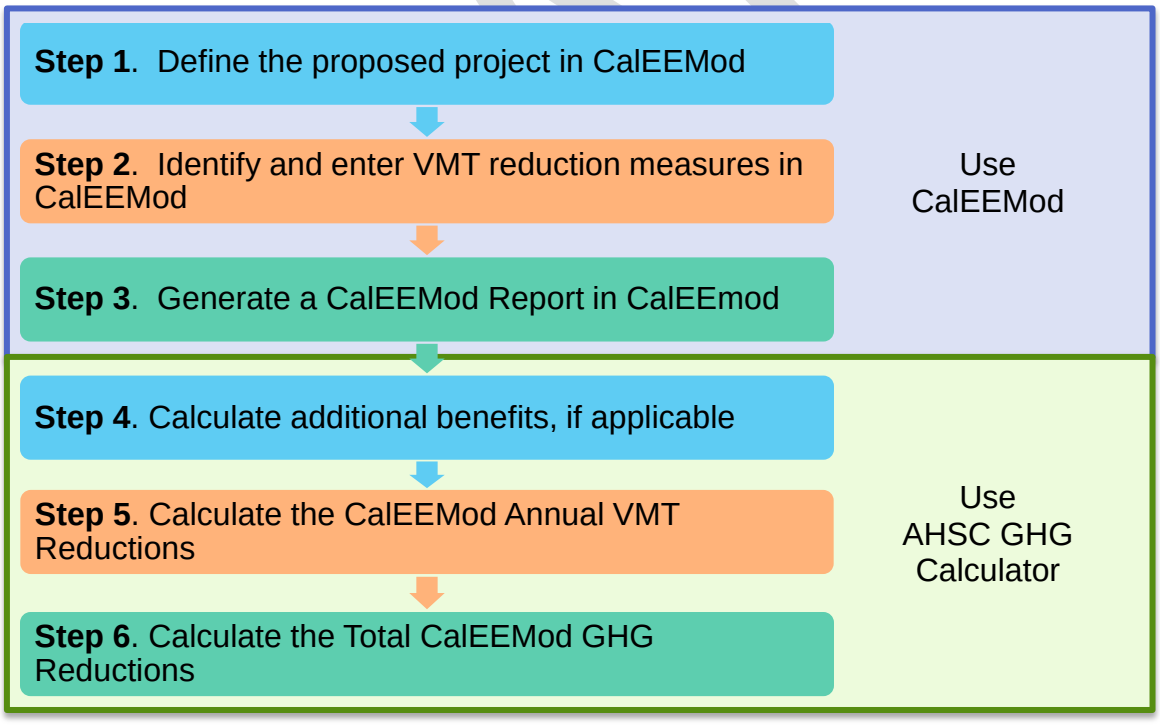
Section B. GHG Quantification Methodology Using CalEEMod

Overview

This quantification methodology estimates the GHG emission reductions of a proposed AHSC project based on the reduction in VMT due to specific project characteristics and project features. CalEEMod combines project specific data with default data to establish an initial case and a project case. The difference between the initial case and project case is the quantified GHG emission reductions from the VMT reduction features identified in the proposed project.

Applicants will follow the steps outlined in Figure 2 to estimate the VMT reductions for the proposed project using CalEEMod. In CalEEMod, the VMT associated with the initial case is referred to as the "Unmitigated VMT" and the VMT associated with the project case is referred to as the "Mitigated VMT." Use CalEEMod for steps 1 through 3 and the AHSC GHG Calculator for steps 4 through 6.

Figure 2. Steps for Estimating VMT Reductions Using CalEEMod

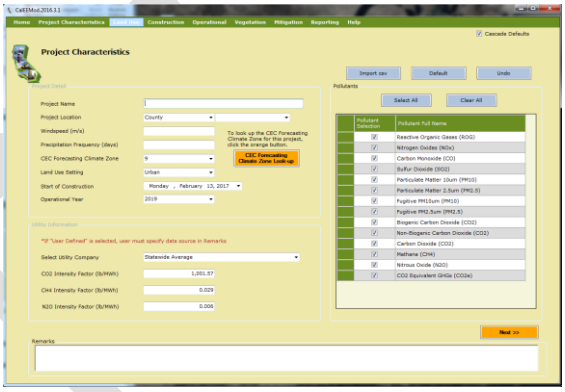


Steps 1—3: Overview

CalEEMod will be used for steps 1 through 3. Refer to the Tools section for more information on CalEEMod and where to obtain the software.

Step 1: Define the Proposed Project

Project Characteristics Screen



Cascade Defaults: Leave this box checked

Project Name: Enter project pin number and project name

Project Location: Select "County" and enter the county of the project site

Climate Zone: Enter any climate zone from the drop-down box[2] (Windspeed and Precipitation will autofill)

Land Use Setting: For RIPA project types, select "Rural;"[3] otherwise, select "Urban"

Start of Construction: Leave as default values[4]

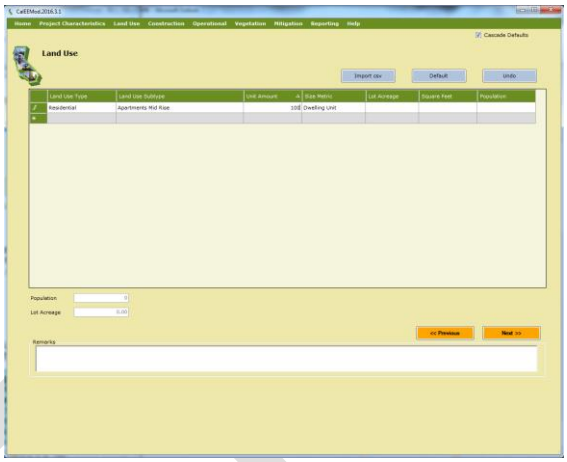
Operational Year: Enter the first year of operation of the proposed project

Select Utility Co.: Select "Statewide Average"[5] (CO_2, CH_4, and N_2O Intensity Factors will autofill)

Pollutants: All boxes should remain checked[4]

[2] The climate zone for a project can be looked up using CalEEMod's User's Guide Appendix F - Climate Zones Zip Code/Cities Lookup, Climate Zone Zip Code/Cities Lookup or the Climate Zone Map. However, the applicant may enter any allowable climate zone as this information is not used for calculations in this quantification methodology.
[3] The use of "rural" must be consistent with the definition in the AHSC Guidelines.
[4] These values are not used in the computation of VMT.
[5] CalEEMod is used to develop VMT estimates only; GHGs are calculated outside of CalEEMod.

Land Use Screen



Cascade Defaults: Leave this box checked

Land Use Type: Select "Residential" or "Commercial" (See Appendix B) (multiple rows may be used to characterize the proposed project)

Land Use Subtype: See Appendix B (multiple rows may be used to characterize the proposed project)

Unit Amount:

Residential Land Use Types:	Enter number of dwelling units
Non-residential Land Use Types:	Enter the square footage in thousands (i.e., if the non-residential floor area is 10,000 square feet, enter "10" as the Unit Amount)

Size Metric:

Residential Land Use Types:	Select "Dwelling Unit"
Non-residential Land Use Types:	Select "1,000 sqft"

Lot Acreage: Leave as default values[4]

Square Feet: Leave as default values[4]

Population: Leave as default values[4]

Applicants should not enter any values into the following screens: Construction, Operational, and Vegetation.

User Tip:
Residential land use types include assumptions on parking; therefore, the applicant does not need to add parking as an additional land use type.

Step 2: Identify and Enter VMT Reduction Measures

Applicants should identify land use and other project features that would result in reduced VMT and enter the applicable project data into the Traffic Mitigation "Land Use & Site Enhancement" screen according to the instructions below.

Mitigation: Traffic → Land Use & Site Enhancement Screen

Project Setting: The Project Setting is used to determine the maximum VMT reductions possible based on the project's location and project-specific features. The Project Settings in CalEEMod are based on the definitions provided in the CAPCOA Quantification Report and are shown in Table 2. For purposes of this quantification methodology, applicants must enter the appropriate Project Setting according to Appendix C. The applicant must provide supporting documentation for the Project Setting selected.

Table 2. Project Settings in the "Land Use & Site Enhancement" Screen

CalEEMod Project Setting Types*	Project Setting Description
Low Density Suburban[6]	**Note: Refer to Appendix C to determine Project Setting Type**
Suburban Center	
Urban	
Urban Center[7]	

*Listed in the order shown in CalEEMod

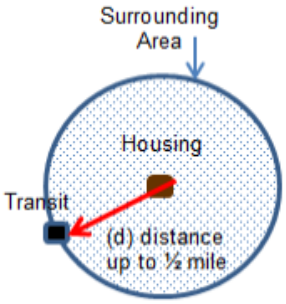
For RIPA Projects: Select "Low Density Suburban"

Select the VMT reduction measures that apply to the project according to Table 3 for Land Use and Site Enhancement Measures. Note that some of the measures will be calculated in Step 5 (Additional Benefits). For each measure selected, applicants must provide supporting documentation.

User Tip:
Applicants must check the appropriate box of the measure and enter any necessary data into CalEEMod. Applicants should not check the box of measures calculated outside of CalEEMod or that do not apply to the project.

[6] Referred to as "Suburban" in the CAPCOA Quantification Report.
[7] Referred to as "Compact Infill" in the CAPCOA Quantification Report.

NOTE: For all measures that rely on features within the project area, the metrics should be evaluated for an area within the housing development and surrounding area which can extend a distance (d) from the housing development not to exceed one-half (½) mile, as shown below. The applicable measures are also denoted with "[(a)]" in Table 3 in the "VMT Reduction Measure" column. For example, the VMT Reduction Measure [PDT-3] "On-Street Market Pricing" indicates the parking policy/pricing should be evaluated according to this note.



Parking Policy/Pricing Measures		
PDT-1	Limit Parking Supply	Project par or eliminat
PDT-2	Unbundle Parking Costs	Project par separate
PDT-3	On-Street Market Pricing[(a)]	On-street p pricing (suc

Table 3. "Land Use & Site Enhancement" VMT Reduction Measures

ID[8]	VMT Reduction Measure	Use this Measure if…	Project Specific Data Inputs Required by CalEEMod[9]	Maximum Potential VMT Reduction by Measure[10]	Maximum Potential VMT Reduction by Group[10]
Land Use & Site Enhancement Measures					
LUT-1	Increase Density	Housing development density is greater than the minimum required dwelling units per acre[11]	**Do not use in CalEEMod; See Step 5** Dwelling units per acre of project	30%	Urban: 65% Urban center: 30% Suburban center: 10% Low density suburban: 5%
LUT-3	Increase Diversity	Multiple land use types in project	Select for mixed-use developments (no additional data required)	30%	
LUT-9	Improve Walkability Design	This measure was removed from use in this quantification methodology.	**Do not use**[12]	21.3%	
LUT-4	Improve Destination Accessibility	Project is within 12 miles of a Central Business District (CBD)	Enter the distance to CBD[13] (>12)	20%	
LUT-5	Increase Transit Accessibility	This measure was removed from use in this quantification methodology.	**Do not use**[14]	24.6%	
LUT-6	Integrate Below Market Rate Housing	Project incorporates affordable housing	**Enter Percentage of units (not # of Units)** that are affordable[15] (0-100)	4%[15]	

[8] Measures listed in the order shown on the CalEEMod screens. IDs reference to the CAPCOA Quantification Report.
[9] Values in parentheses indicate valid inputs.
[10] Range of effectiveness derived from the CAPCOA Quantification Report, except as noted.
[11] Revision to the equation for calculating LUT-1 in the "Additional Benefits" section of the AHSC GHG Calculator tool to adjust the baseline density to be consistent with the minimum required dwelling units per acre in the AHSC Guidelines for the applicable project setting
[12] Measure has been removed to circumvent duplicative scoring to the walkability index
[13] See Appendix D. Central Business District. Applicants can estimate the Distance to CBD through this site: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/kml/jobcentermap.html
[14] Measure has been removed since all AHSC projects are required to be within half-mile of transit.
[15] The CAPCOA Quantification Report states the maximum reduction potential as 1.2%; however, the maximum reduction potential is 4% (see http://www.montgomeryplanning.org/transportation/documents/TripGenerationAnalysisUsingURBEMIS.pdf). The reduction is applied correctly in CalEEMod.

Table 3. (continued) "Land Use & Site Enhancement" VMT Reduction Measures

ID[8]	VMT Reduction Measure	Use this Measure if…	Project Specific Data Inputs Required by CalEEMod[9]	Maximum Potential VMT Reduction by Measure[10]	Maximum Potential VMT Reduction by Group[10]
Neighborhood Enhancement Measures					
SDT-1	Improve Pedestrian Network[(a)]	Project area includes a pedestrian access network	**Do not use in CalEEMod; See Section C** "	2%	5%
SDT-2	Provide Traffic Calming Measures[(a)]	Project's streets and intersections feature traffic calming features (Complete Street features)[16]	**Do not use in CalEEMod; See Step 4**	1%	
SDT-3	Implement NEV Network	This measure was removed from use in this quantification methodology	**Do not use**[17]	12.7%	
Parking Policy/Pricing Measures					
PDT-1	Limit Parking Supply	Project parking requirements are reduced or eliminated	% reduction in residential spaces below ITE avg. weekday parking generation rate[18] (0-25)[19]	12.5%	20%
PDT-2	Unbundle Parking Costs	Project parking and property costs are separate	Monthly parking cost (0-200)	20%[20]	
PDT-3	On-Street Market Pricing[(a)]	On-street parking utilizes market-rate pricing (such as meters)[21]	% increase in price (0-50)	5.5%	

[16] Applicants will be required to document which traffic calming feature(s) will be implemented in order to take credit for this measure.
[17] This measure pertains to low-speed, arterial road vehicles, as classified in the California Vehicle Code Section 385.5.
[18] See Appendix B for default ITE parking rates.
[19] The CAPCOA Quantification Report states that the maximum reduction potential is 12.5%; however, CalEEMod allows up to 20% reduction. Users may only enter a % reduction up to 25%.
[20] The CAPCOA Quantification Report states that the maximum reduction potential is 13% for parking costs of $125; however, CalEEMod allows up to 20% reduction for parking costs of $200.
[21] If the project area will increase parking rates between the time of application to building occupancy and the rate of increase is known, applicants may use this measure. Users may only enter an increase in price up to 50%.

Table 3. (continued) "Land Use & Site Enhancement" VMT Reduction Measures

ID[8]	VMT Reduction Measure	Use this Measure if…	Project Specific Data Inputs Required by CalEEMod[9]	Maximum Potential VMT Reduction by Measure[10]	Maximum Potential VMT Reduction by Group[10]
Transit Improvement Measures					
TST-1	Provide BRT System[(a)]	These measures have been relocated to the TAC Methods.	**Do not use in CalEEMod; See Section C**	3.2%	10%
TST-3	Expand Transit Network[(a)]			7.4%	
TST-4	Increase Transit Frequency[(a)]			3.1%	

Step 3: Generate a CalEEMod Report

Reporting Screen

Select "Annual"

Click "Recalculate All Emissions and Run Report"

User Tip:
GHG emissions are calculated outside of CalEEMod based on the VMT estimates generated in CalEEMod.

CalEEMod will generate a report that includes annual Total VMT estimates of the project for both the initial case, which is identified as "unmitigated" in the CalEEMod report, and the project case, identified as "mitigated." The VMT outputs are found in the Section 4.2 as shown in Figure 3. The unmitigated annual VMT is the estimated VMT that would occur if the project did not include the mitigation features selected in CalEEMod; the mitigated annual VMT accounts for the land use features selected. These CalEEMod outputs will be used as inputs to the ARB-developed AHSC GHG Calculator tool, which is described in steps 4 through 6.

Figure 3. CalEEMod Report Section 4.2 VMT Output

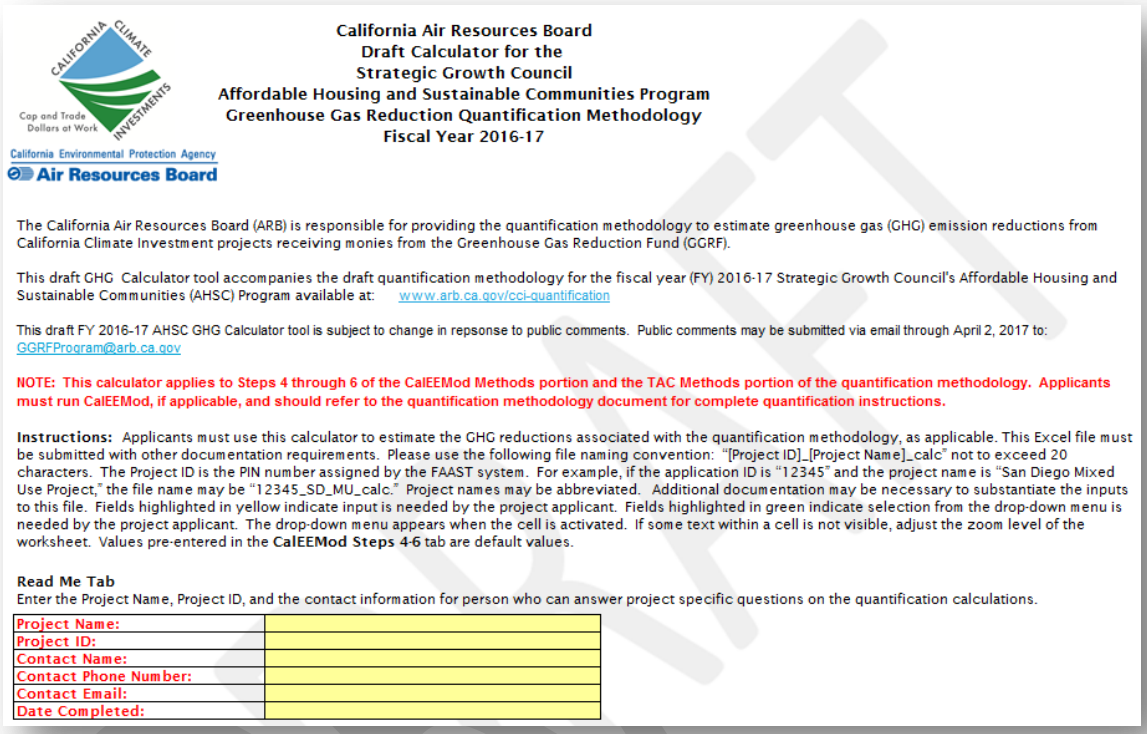
4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Apartments Mid Rise	659.00	716.00	607.00	1,882,065	1,466,443
Total	659.00	716.00	607.00	1,882,065	1,466,443

Applicants must submit both the input and output files used to generate the VMT data, in Excel format. Applicants are requested to name the input and output files using the following format: "[Pin#]_[ProjectName]_input/output" not to exceed 20 characters. For example, if the application pin number is "12345," the project name is "San Diego Bay Housing," and the file is the input file, the file name may be "12345_SDBay_input." Project names may be abbreviated.

Steps 4—6: Overview

Applicants must use the Excel-based AHSC GHG Calculator tool for steps 4 through6. The equations used in the calculations are based on CalEEMod and the CAPCOA Quantification Report and are provided in Appendix E. The AHSC GHG Calculator tool can be downloaded from the California Climate Investment quantification materials website at: www.arb.ca.gov/cci-quantification. Applicants must begin with the **Read Me** tab, which contains instructions and prompts users to enter project information.



California Air Resources Board
Draft Calculator for the
Strategic Growth Council
Affordable Housing and Sustainable Communities Program
Greenhouse Gas Reduction Quantification Methodology
Fiscal Year 2016-17

The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate greenhouse gas (GHG) emission reductions from California Climate Investment projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF).

This draft GHG Calculator tool accompanies the draft quantification methodology for the fiscal year (FY) 2016-17 Strategic Growth Council's Affordable Housing and Sustainable Communities (AHSC) Program available at: www.arb.ca.gov/cci-quantification

This draft FY 2016-17 AHSC GHG Calculator tool is subject to change in repsonse to public comments. Public comments may be submitted via email through April 2, 2017 to: GGRFProgram@arb.ca.gov

NOTE: This calculator applies to Steps 4 through 6 of the CalEEMod Methods portion and the TAC Methods portion of the quantification methodology. Applicants must run CalEEMod, if applicable, and should refer to the quantification methodology document for complete quantification instructions.

Instructions: Applicants must use this calculator to estimate the GHG reductions associated with the quantification methodology, as applicable. This Excel file must be submitted with other documentation requirements. Please use the following file naming convention: "[Project ID]_[Project Name]_calc" not to exceed 20 characters. The Project ID is the PIN number assigned by the FAAST system. For example, if the application ID is "12345" and the project name is "San Diego Mixed Use Project," the file name may be "12345_SD_MU_calc." Project names may be abbreviated. Additional documentation may be necessary to substantiate the inputs to this file. Fields highlighted in yellow indicate input is needed by the project applicant. Fields highlighted in green indicate selection from the drop-down menu is needed by the project applicant. The drop-down menu appears when the cell is activated. If some text within a cell is not visible, adjust the zoom level of the worksheet. Values pre-entered in the **CalEEMod Steps 4-6** tab are default values.

Read Me Tab
Enter the Project Name, Project ID, and the contact information for person who can answer project specific questions on the quantification calculations.

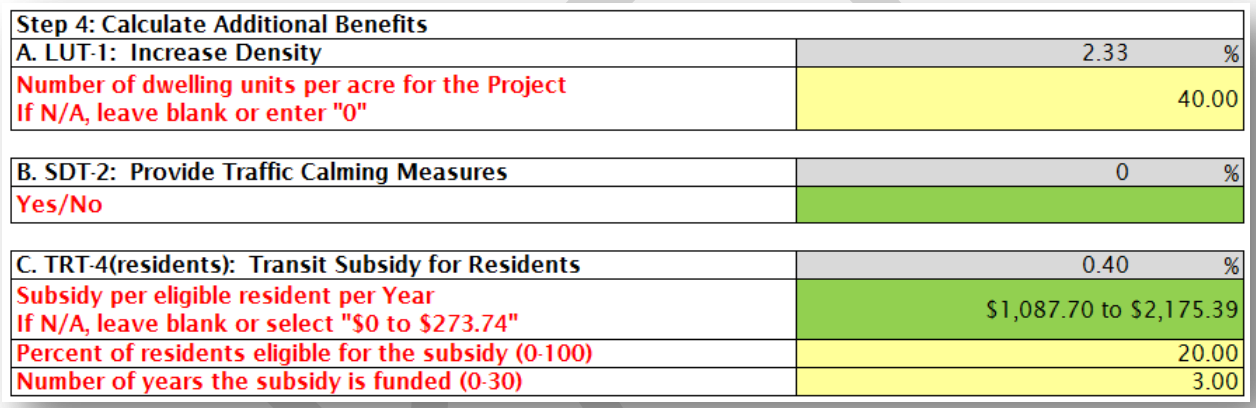
Project Name:	
Project ID:	
Contact Name:	
Contact Phone Number:	
Contact Email:	
Date Completed:	

Step 4: Calculate Additional Benefits

Applicants should enter the requested information for the measures that apply to the project in the "CalEEMod Steps 4-6" tab of the AHSC Calculator tool. The AHSC GHG Calculator tool will display the percent VMT reductions by measure. For measures that do not apply to the project, inputs should be left as defaults, resulting in no change to VMT for the measure(s).

The AHSC GHG Calculator tool provides additional benefits for the following measures if applicable to the proposed project, as described in Tables 3 and 4:

A. LUT-1: Increase Density
B. SDT-2: Provide Traffic Calming Measures
C. TRT-4(residents): Transit Subsidy for Residents. Note: The CalEEMod Transit Subsidy is applicable to non-residential land use types (for employees). This adjustment has been provided to apply transit subsidies to residents.



Step 4: Calculate Additional Benefits		
A. LUT-1: Increase Density	2.33	%
Number of dwelling units per acre for the Project If N/A, leave blank or enter "0"	40.00	
B. SDT-2: Provide Traffic Calming Measures	0	%
Yes/No		
C. TRT-4(residents): Transit Subsidy for Residents	0.40	%
Subsidy per eligible resident per Year If N/A, leave blank or select "$0 to $273.74"	$1,087.70 to $2,175.39	
Percent of residents eligible for the subsidy (0-100)	20.00	
Number of years the subsidy is funded (0-30)	3.00	

Step 5: Calculate the CalEEMod Annual VMT Reductions

This Step calculates the annual VMT reductions according to the project features and the maximum potential reductions according to the Project Setting as listed in Table 4. This Step is automated and no user input is required.

Table 4. Maximum Potential Reductions by Project Setting Type

CalEEMod Project Setting Types*	Maximum Potential Reductions (Total maximum project VMT reduction)[22]
Low Density Suburban	15%
Suburban Center	20%
Urban Center	40%
Urban	75%

*Listed in order of increasing maximum potential reductions

Step 6: Calculate the Total CalEEMod GHG Emission Reductions

This Step converts the annual VMT reductions to annual GHG emission reductions and calculates the GHG emission reductions over the life of the project, 30 years. This Step is automated and no user input is required. Information on the emission factors used to convert VMT reductions to GHG emission reductions is available in Appendix F.

Step 5: Calculate the CalEEMod Annual VMT Reductions		
Additional % VMT Reductions (A+B+C from Step 4)	2.73	%
Additional VMT Reductions	51,443.11	VMT
Total Annual VMT Reductions	467,065.11	VMT
Percent VMT Reduction	25%	%
Maximum Potential Annual Reductions	40%	VMT
Annual CalEEMod VMT Reductions	**467,065.11**	**VMT**
Step 6: Calculate the Total CalEEMod GHG Emission Reductions		
CalEEMod GHG Emission Reductions (Yr 1)	236.68	MT CO_2e
CalEEMod GHG Emission Reductions (Yr F)	141.09	MT CO_2e
Total CalEEMod GHG Emission Reductions	**5,666.61**	MT CO_2e

If your project has features requiring use of TAC Methods, go to **Section C. GHG Quantification Methodology Using TAC Methods**; otherwise, go to **Section D. Documentation**.

[22] As defined in the CAPCOA Quantification Report. The interactions among transportation-related measures are complex and sometimes counter-intuitive. The maximum reduction values are derived from the percentage difference in per capita VMT compared against a statewide average and reflect the highest reduction levels justified by the literature as reviewed for the CAPCOA Quantification Report.

Section C. GHG Quantification Methodology Using TAC Methods

Overview

TAC Methods are provided for eligible capital projects (e.g., sustainable transportation infrastructure, transit-related amenities, etc.) and program costs (e.g., Active Transportation Programs) that encourage mode-shift that are not quantified in CalEEMod. Applicants should identify the applicable TAC Method(s) as described in Table 5 based on the proposed project features. For GHG quantification purposes, eligible AHSC projects fall into the three project types.

Table 5. TAC Methods by Project Type

Project Type	Description	TAC Method
Operation of New/Expanded Bus, Train, Ferry, Vanpool, or Shuttle Service	Expansion of transit service through new service, additional routes, extended routes, extended service hours, increased frequency of service, or increased capacity.	$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos - GHG\ Emissions\ of\ New/Expanded\ Service\ Vehicle$
Capital Improvements (that encourage mode-shift)	Capital Improvements that result in an increase in transit ridership such as: new transit facilities that connect to bike or pedestrian paths; upgrades to transit stops/stations (e.g., bike-sharing facilities, bike racks/lockers, covered benches); and upgrades to transit vehicles (e.g., bicycle racks on buses, bicycle storage on rail cars).	$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos$
Active Transportation	Bicycle Paths (Class 1), Bicycle Lanes (Class 2), Protected Bikeways (Class 4), Bike Share, or Pedestrian Facilities, that are targeted to reduce commute and other non-recreational auto travel	$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos$

Projects that implement new and expanded transit service or capital improvement that generate increased ridership result in net GHG emission reductions by facilitating mode-shift from auto trips to transit trips, reducing VMT.

Pedestrian and bike facility construction projects and bike share projects result in net GHG emission reductions by replacing auto trips with walking or bicycle trips, which reduce VMT.

Pedestrian facilities replace auto trips by providing or improving pedestrian access. An example is a pedestrian passageway over several lanes of heavy traffic providing safe walking access to adjacent activity centers.

GGRF eligible bike facilities include Class 1, Class 2, and Class 4 bikeways, as defined below (from Assembly Bill 1193[iii]).

- Class 1 bike paths or shared-use paths provide a completely separated right-of-way designated for the exclusive use of bicycles and pedestrians with crossflows by motorists minimized.

- Class 2 bike lanes provide a restricted right-of-way designated for the exclusive or semi-exclusive use of bicycles with through travel by motor vehicles or pedestrians prohibited, but with vehicle parking and crossflows by pedestrians and motorists permitted.

- Class 4 separated bikeways provide a right-of-way designated exclusively for bicycle travel adjacent to a roadway and which are protected from vehicular traffic by features such as grade separation, physical barriers, or on-street parking.

Multi-use projects (i.e., Class 1 Bike Path) that will result in reduced VMT from bicycle and pedestrian uses may account for both uses. Contiguous projects are considered to be a single project for quantification of GHG emission reductions.

Note that Class 3 bike routes, which provide a right-of-way designated by signs or permanent markings and shared with pedestrians and motorists, are not currently quantified in this methodology.

New and expanded bike share projects reduce VMT by providing access to bicycles and therefore replacing auto trips with bike trips.

Note: The AHSC Program estimates GHG reductions associated with a decrease in VMT from a new or expanded transportation service or capital improvements that encourage mode-shift. GHG reductions associated with replacement of vehicles in an existing service are not quantified.

AHSC GHG Calculator

Applicants must use the AHSC GHG Calculator to determine GHG reductions associated with proposed GGRF-funded projects. An example project showing how to use the AHSC GHG Calculator tool is provided in Appendix A. The equations used to estimate VMT in the calculations are based on the CMAQ Methods and are provided in Appendix E. Information on the emission factors used to convert VMT reductions to GHG emission reductions is available in Appendix F. The draft AHSC GHG Calculator tool can be downloaded from: www.arb.ca.gov/cci-quantification.

Users should begin with the **Read Me** tab, which contains instructions and prompts users to enter project information. Key terms are defined in the **Definitions** tab. The **TAC Inputs** tab identifies inputs required by the user, generally requiring project-specific data or assumptions. Input and output fields are color coded:

- Yellow fields indicate a direct user input is required.
- Green fields indicate a selection from a drop-down box is required.
- Gray fields indicate output or calculation fields that are automatically populated based on user entries and the calculation methods.

Details of calculation methods are provided in Appendix E.

Table 6 and Table 7 below indicate which factors in the **TAC Inputs** tab require input from the applicant ("✓"), and which values are either not applicable or have default values programmed into the AHSC GHG Calculator (shaded cells) for bike and pedestrian projects and for transit projects respectively .

Table 6. TAC Input Requirements for Bike and Pedestrian Projects

Input	Description	Project-Level Data Required		
		Bike Infrastructure	**Pedestrian Infrastructure**	**Bike Share**
Year 1	First Year of Project	✓	✓	✓
Year F	Final Year of Useful Life	**Class 1:** 20 years **Class 2/4:** 15 years	20 years	10 years
Days of operation per year of new service (D)	Days of use per year of new service	200	200	
Length of average auto trip reduced (L)	Length of bike or walk trip	1.8 miles	1.0 mile	1.8 miles
Average Daily Traffic (ADT)	Annual Average Daily Traffic (two-way traffic volume in trips/day on parallel road). Use applicable value from project data (Maximum = 30,000)	✓	✓	
Yr1 Trips	Total number of bike trips using bike share bikes expected in the first year of service			✓
Adjustment Factor (A)	**New Bike/Ped Infrastructure:** Adjustment factor to account for bike/pedestrian use. **Bike Share:** Discount factor applied to annual ridership to account induced demand and non-utilitarian or commuting use	Refer to Table B-1 in Appendix B	Refer to Table B-1 in Appendix B	0.5
Activity Center Credit (C)	Activity Center Credit near project	Refer to Table B-2 in Appendix B	Refer to Table B-2 in Appendix B	

Table 7. TAC Input Requirements for Transit Projects

Input	Description	Project-Level Data Required			
		Bus / Shuttle / Vanpool	Train	Ferry	Capital Imp.
Year 1	First Year of Project	✓	✓	✓	✓
Year F	**New/Expanded Service:** Last year of enforceable committed funds for the operation of the new/expanded service **Capital Improvements:** Last year of the useful life	✓	✓	✓	✓
Days of operation per year (D)	Days of use per year	Weekday Service: 260 Daily Service: 365	Weekday Service: 260 Daily Service: 365	Weekday Service: 260 Daily Service: 365	Weekday Service: 260 Daily Service: 365
Daily ridership (R)	Change in Daily Ridership as a result of the project (may be different for Yr 1 and Yr F)	✓	✓	✓	✓
Adjustment factor (A)	Adjustment factor to account for transit dependency	Local Bus: 0.5 Long Distance Commuter Bus, Shuttle, and Vanpool: 0.83	✓	✓	✓
Length (L)	Length of average auto trip reduced	Bus: 10.8 Shuttle: 16 Vanpool: 35	✓	✓	✓
Fuel Type	Fuel type of the new service vehicle	✓	✓	✓	
Engine MY	The engine model year of the new/expanded vehicle proposed for service, if applicable	✓			
Annual VMT / Units of Fuel	The annual VMT or units of fuel of the proposed service	VMT	VMT	Units of Fuel	

Once the TAC Methods have been completed, go to **Section D. Documentation**.

Section D. Documentation

In addition to AHSC application requirements, applicants applying for GGRF funding are required to document results from the use of this quantification methodology, including supporting materials to verify the accuracy of project-specific inputs.

Applicants are required to provide electronic documentation that is complete and sufficient to allow the calculations to be reviewed and replicated. Paper copies of supporting materials must be available upon request by agency staff.

The following checklist is provided as a guide to applicants; additional data and/or information may be necessary to support project-specific input assumptions.

	Documentation Description	Completed
1.	Contact information for the person who can answer project specific questions from staff reviewers on the quantification calculations	
2.	Project description, including excerpts or specific references to the location in the main AHSC application of the project information necessary to complete the applicable portions of the quantification methodology	
3.	Populated AHSC GHG Calculator tool file (in .xlsm) with worksheets applicable to the project populated (ensure that the Total Project GHG Emission Reductions, Total Project GHG Emission Reductions/AHSC GGRF Funds Requested, and Total Project GHG Emission Reductions/Total GGRF Funds Requested fields in the summary worksheet contain calculated values)	
4.	If the Total GGRF funds requested are different than the AHSC GGRF funds requested, provide an explanation of the other GGRF program(s) where funding is sought, including the fiscal year of the application(s)	
5.	Electronic copies of the CalEEMod input and output files as described in Step 3 of Section B, including: • A list of the VMT reduction measures used in the proposed project with clearly identified project specific input data used in Section B • Documentation for determining Distance to Central Business District and Project Setting Type	
6.	Any other information as necessary and appropriate to substantiate inputs (e.g., Project Setting or Ridership)	

Total Project GHG Emission Reductions is equal to the sum total of each of the GHG Reductions calculated in Sections B and C and are automatically summed in the AHSC GHG calculator in the **GHG Summary** tab.

Total Project GHG Emission Reductions per dollars of AHSC requested is calculated as:

$$\frac{Total\ Project\ GHG\ Emission\ Reductions\ in\ Metric\ tons\ (MT)\ of\ CO_2e}{AHSC\ Funds\ Requested\ (\$)}$$

Applicants should enter the AHSC Funds Requested ($) into the AHSC GHG calculator for all project features. The AHSC GHG calculator will provide the Total GHG Emission Reductions per AHSC Funds Requested.

Total Project GHG Emission Reductions per dollars of GGRF requested is calculated as:

$$\frac{Total\ Project\ GHG\ Emission\ Reductions\ in\ Metric\ tons\ (MT)\ of\ CO_2e}{Total\ GGRF\ Funds\ Requested\ (\$)}$$

Applicants should enter the GGRF Funds Requested ($) into the AHSC GHG calculator for all project features. The AHSC GHG calculator will provide the Total GHG Emission Reductions per GGRF Funds Requested.

The dollars requested from AHSC may be different from the dollars requested from GGRF if the applicant has applied for, anticipates applying for, or received funding for the proposed project through a separate GGRF program. If no other GGRF funds are requested, the Total Project GHG Emissions Reductions per dollars of GGRF and AHSC will be the same.

Applicants are required to provide electronic documentation that is complete and sufficient enough to allow the quantification calculations to be reviewed and replicated. Paper copies of any materials must be available upon request by SGC or ARB staff.

Section E. Reporting after Funding Award

Accountability and transparency are essential elements for all GGRF California Climate Investment projects. As described in ARB's Funding Guidelines, each administering agency is required to track and report on the benefits of the California Climate Investments funded under their program(s). Each project funded by the GGRF is expected to provide real and quantifiable GHG emission reductions. The previous sections of this document provide the methods and tools to estimate the GHG emission reductions of a proposed project based on project characteristics and assumptions of expected conditions and activity levels. This section explains the minimum reporting requirements for administering agencies and funding recipients during project implementation, termed Phase 1, and after a project is completed, termed Phase 2. Table 7 below shows the project phases and when reporting is required.

Table 7. Quantification and Reporting By Project Phase

	Timeframe & Reporting Frequency	Quantification Methods
Project Selection	Period from solicitation to funding awards. Applicant submits application to SGC by due date in solicitation materials.	All applicants use methods in ARB's quantification methodology to estimate the GHG emission reductions of the project.
Phase 1	Period from project award date through project completion date. SGC reports to ARB on an annual basis.	All funded projects use methods in ARB's quantification methodology to update initial estimates of GHG emission reductions, as needed, based on project changes.
Phase 2	Starts after Phase 1 is complete and a project becomes operational. SCG reports to ARB consistent with the Funding Guidelines.	GHG emission reduction estimates are updated and reported for a subset of funded projects.

Funding recipients have the obligation to provide, or provide access to, data and information on project outcomes to SGC.

It is the responsibility of SGC to collect and compile project data from funding recipients, including GHG emission reductions and information on benefits to disadvantaged communities.

Phase 1 reporting is required for all AHSC funded projects. SGC will collect and submit data to ARB to satisfy Phase 1 reporting requirements. Funding recipients must report any changes that impact GHG emission reduction estimates (i.e. assumptions or quantities) to SGC prior to project completion.

Phase 2 reporting is required for only a subset of AHSC projects and is intended to document actual project benefits achieved after the project becomes operational.

Phase 2 data collection and reporting will not be required for every project. SGC will be responsible for identifying the subset of individual projects that must complete Phase 2 reporting, identifying who will be responsible for collecting Phase 2 data, and for reporting the required information to ARB. ARB will work with SGC to address Phase 2 procedures, including but not limited to:

- The **timelines** for Phase 2 reporting, i.e., when does Phase 2 reporting begin, how long will Phase 2 reporting be needed.
- As applicable, **approaches for determining the subset of projects** that need Phase 2 reporting (i.e., how many **X** projects out of **Y** total projects are required to have Phase 2 reporting).
- **Methods for monitoring or measuring** the necessary data to quantify and document achieved GHG reductions and other select project benefits.
- **Data to be collected**, including data fields needed to support quantification of GHG emission benefits.
- Reporting requirements for transmitting the data to ARB or Caltrans for program transparency and use in reports.

Once the Phase 2 quantification method and data needs are determined, ARB will develop and post the final ARB approved Phase 2 methodology for use in Phase 2 reporting.

[i] As described in Volume 1 of the California Air Resources Board. Funding Guidelines for Agencies Administering California Climate Investments (December 21, 2015) (Funding Guidelines). www.arb.ca.gov/cci-fundingguidelines

[ii] California Air Pollution Control Officers Association. Quantifying Greenhouse Gas Mitigation Measures. August 2010. http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf.

[iii] Assembly Bill 1193, available at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1193

Appendix A. Example Project

Introduction

The following is a hypothetical project[1] to demonstrate how the FY 16-17 AHSC Program Quantification Methodology would be applied. This example does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project is a collaborative **TOD** project between a housing developer and a transit agency, proposing the following components:

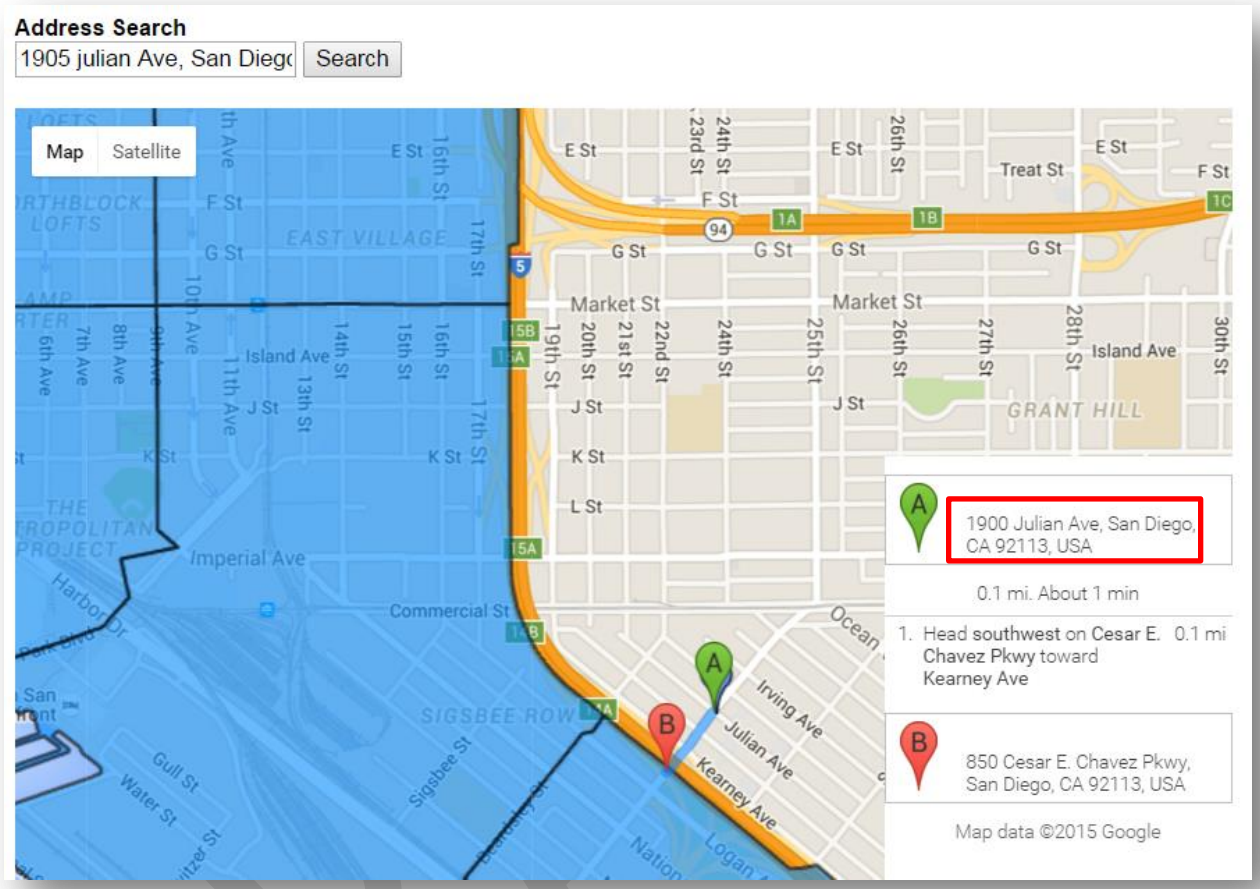
- Mixed-use development with affordable housing
- New bus service

The proposed project is located in San Diego County with the following project features:

- First year of development operation: 2019.
- 4-story rental development with 80 units; 75% are affordable.
- 3,000 square feet of commercial use.
- 2.0 acres (40 dwelling units per acre).
- Traffic calming measures (roundabouts).
- 1 parking space per dwelling unit (ITE default average weekday parking rate for a mid-rise urban apartment is 1.2 spaces per dwelling unit. This quantification methodology is requiring reductions from residential only; therefore, the project has a reduction in parking spaces of 18.7% [(1-1.23)/1.23]).
- The new hydrogen-powered bus service would be funded by AHSC funds for three years and therefore can demonstrate 3 years of operational funds. No subsidy is provided to riders.
- The new bus service would begin operation in 2019 and consist of 2 model year 2018 model year buses, with a ridership of 500 passengers per day on a daily service schedule.
- The new bus service would run 40,000 miles (total for 2 buses) per year.
- The application request is for $5,000,000 from the AHSC Program. No other GGRF funding is being or has been sought.
- The distance to the nearest Central Business District (CBD) is 0.1 miles, as shown on the next page.
- PIN number assigned by FAAST system: 12345.

[1] The hypothetical project has not undergone verification of any AHSC Program requirements; all assumptions about location type and features are for quantification methodology demonstration purposes only.

Refer to Appendix D for instructions on estimating Distance to CBD.



Methods to apply

According to Table 1 in the Quantification Methodology, the applicant would use CalEEMod for the development portion of the project and TAC Methods for the new bus service.

As described in Section A of the quantification methodology, users can download CalEEMod for free at www.caleemod.com. For Steps 4 through 6 of the CalEEMod component, the TAC Methods component, and some of the documentation components, ARB has developed an Excel-based calculator. All applicants must use the calculator for the applicable components of their project. The calculator is available at ARB's Auction Proceeds Quantification Page, under the SGC's AHSC Program: www.arb.ca.gov/cci-quantification.

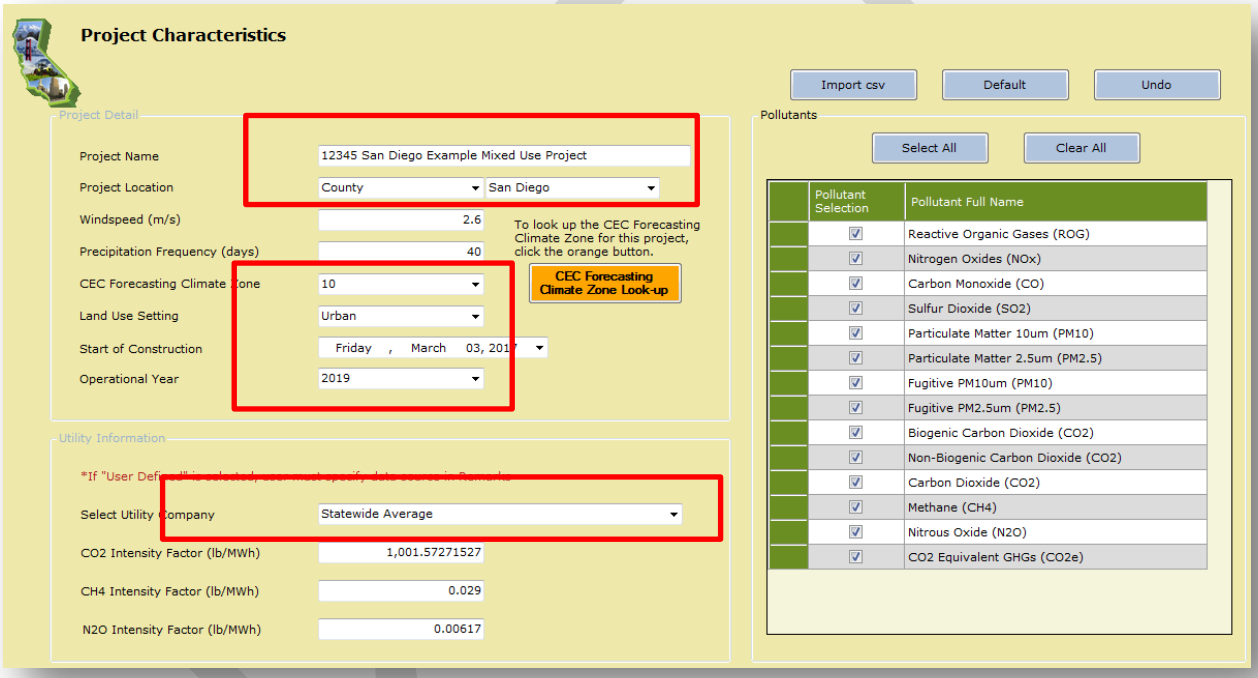
CalEEMod component

Step 1: Define the proposed project in CalEEMod

Project Characteristics Screen

Note: Include PIN number in Project Name

Project Name: 12345 San Diego Example Mixed Use Project
Project Location: "County" and San Diego
Climate zone: Choose any allowable zone
Land Use Setting: This is not a RIPA project, so select "Urban"
Start of Construction: Remain as default date
Utility: Statewide Average
Pollutants: All pollutants shall remain selected

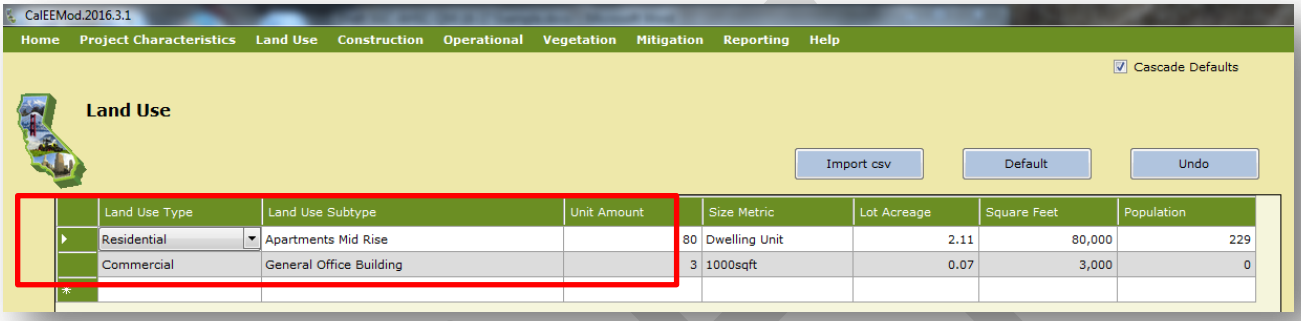


Click "Next."

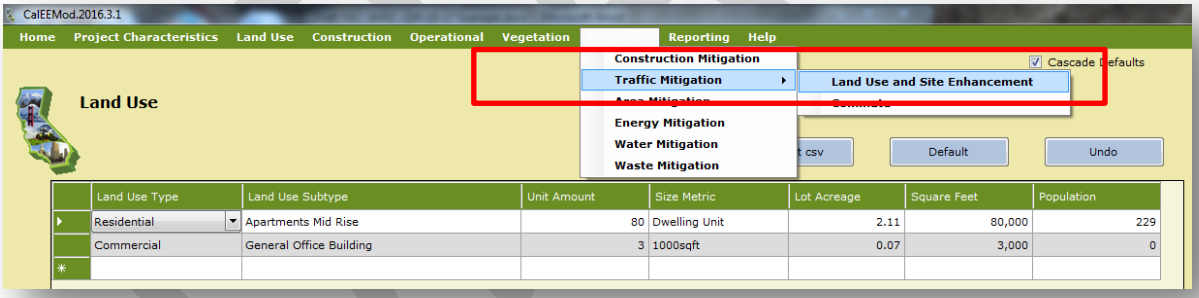
Land Use Screen

Refer to Appendix B to determine the appropriate Land Use Type and Land Use Subtype for each project component. Since the proposed project is a four-story rental apartment, it is classified as "Apartment Mid Rise" and all non-residential property is classified as "General Office Building."

Line 1: Residential, Apartment Mid-rise, "80" for the number of dwelling units
Line 2: Commercial, General Office Building, "3" for "thousands of square feet"



Select "Mitigation" > "Traffic Mitigation" > "Land Use and Site Mitigation."



Step 2: Identify and Enter VMT Reduction Measures

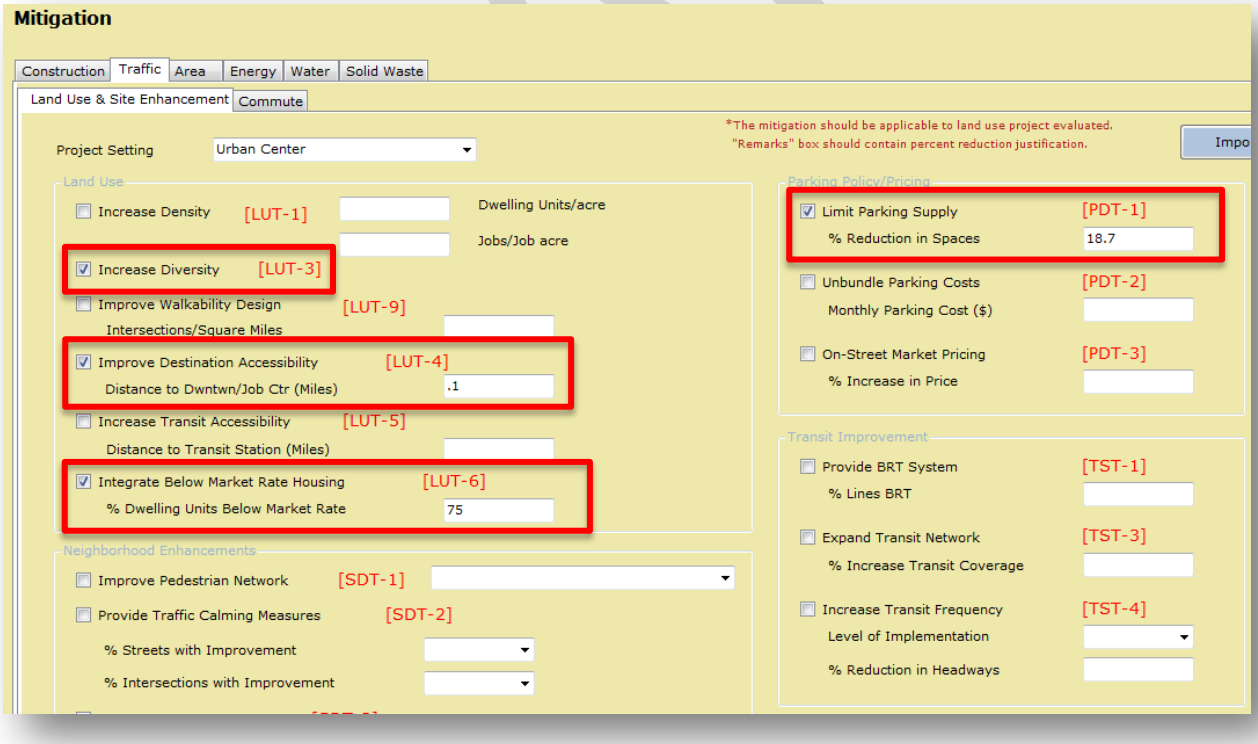
Mitigation: Traffic, Land Use & Site Enhancement Screen

Refer back to Table 3 of the quantification methodology for additional information by measure. Note: CalEEMod may prompt the user to enter "Remarks" on some screens. These will not be reviewed as the supporting documentation for inputs.

Project Setting: "Urban Center"[2]
The project has the following features:
LUT-1, LUT-3, LUT-4, LUT-6, SDT-2 and PDT-1.
LUT-1 and SDT-2 are calculated outside of CalEEMod and must not be selected in CalEEMod.

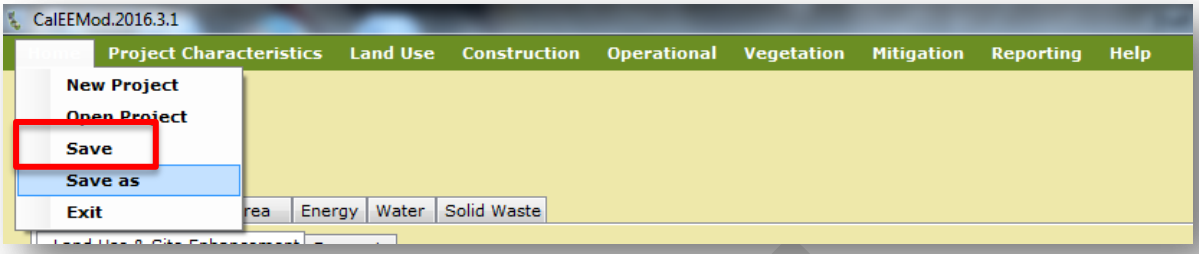
Enter the following in CalEEMod:
LUT-3: Check the box.
LUT-4: Check box and enter ".1" for Distance to CBD.
LUT-6: Check box and enter "75" for percent of units below market rate.
PDT-1: Check the box and enter "18.7" for percent reduction in spaces.

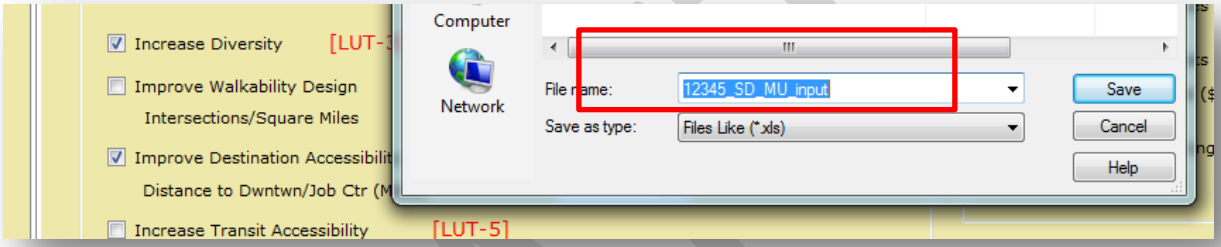
The other measures will be estimated in Step 4.



[2] The Project Setting selected is for demonstration purposes only. No analysis has been conducted to determine the Project Setting type for this location.

Under the Home tab, select “Save As” and save the input file as “12345_SD_MU_input.”



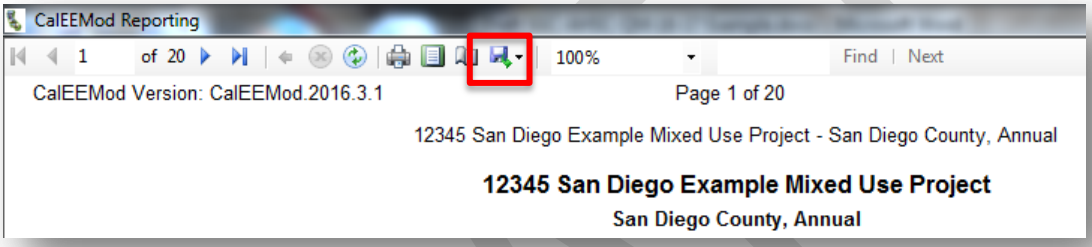


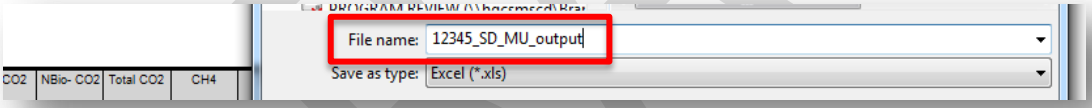
Step 3: Generate a CalEEMod Report

Select “Reporting.”

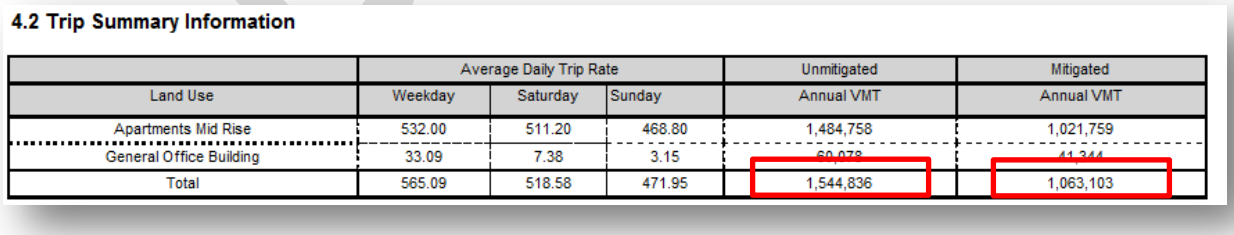
To run the model, select “Annual” and click on “Recalculate All Emissions and Run Report.” **Allow the program several minutes to run.**

Export the output as an Excel file named “12345_SD_MU_output.”





The output will include unmitigated annual VMT and mitigated annual VMT totals under Trip Summary Information, which will be used in the next steps.



4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Apartments Mid Rise	532.00	511.20	468.80	1,484,758	1,021,759
General Office Building	33.09	7.38	3.15	60,078	41,344
Total	565.09	518.58	471.95	1,544,836	1,063,103

Step 4—6

For Steps 4 through 6, use the Excel-based calculator. The CalEEMod mitigated and unmitigated VMT and other project features will be used as inputs to the calculator.

The **Read Me** tab contains important instructions and basic project information must be inputted here.

Read Me Tab

Enter the Project Name, Project ID, and the contact information for person who can answe

Project Name:	12345 San Diego Mix Use
Project ID:	12345
Contact Name:	Any R Body
Contact Phone Number:	(619) 555-5555
Contact Email:	ARB@account.com
Date Completed:	3/3/2017

Proceed to the **CalEEMod Steps 4-6** tab and enter the basic project information in the green and yellow cells. The information entered must match the inputs (County, Project Type, Project Setting, and Year 1) and outputs (Unmitigated VMT and Mitigated VMT) from CalEEMod.

Project Name:	12345 San Diego Mix Use
Project ID:	12345

Project County	San Diego
Unmitigated VMT from the CalEEMod Report	1,544,836
Mitigated VMT from the CalEEMod Report	1,063,103
Project Type	TOD
Project Setting (must match CalEEMod Project Setting)	Urban Center
Year 1 (first operational year)	2019

Step 4: Calculate Additional Benefits

LUT-1 and SDT-2 apply to the project. Applicant should enter the number of dwelling units per acre for the Project as “40” and select “Yes” for providing traffic calming measures (see below). No other fields should be modified as the other measures are not applicable to the project.

Step 4: Calculate Additional Benefits		
A. LUT-1: Increase Density	2.33	%
Number of dwelling units per acre for the Project If N/A, leave blank or enter "0"	40.00	
B. SDT-2: Provide Traffic Calming Measures	1	%
Yes/No	Yes	
C. TRT-4(residents): Transit Subsidy for Residents	0.00	%
Subsidy per eligible resident per Year If N/A, leave blank or select "$0 to $273.74"		
Percent of residents eligible for the subsidy (0-100)		
Number of years the subsidy is funded (0-30)		

Step 5: Calculate the CalEEMod Annual VMT Reductions

This Step is automated. The calculator determines the annual VMT reductions.

Step 5: Calculate the CalEEMod Annual VMT Reductions		
Additional % VMT Reductions (A+B+C from Step 4)	3.33	%
Additional VMT Reductions	51,494.53	VMT
Total Annual VMT Reductions	533,227.53	VMT
Percent VMT Reduction	35%	%
Maximum Potential Annual Reductions	40%	VMT
Annual CalEEMod VMT Reductions	**533,227.53**	**VMT**

Step 6: Calculate the Total CalEEMod GHG Reductions

The calculator estimates the Total CalEEMod GHG reductions.

Step 6: Calculate the Total CalEEMod GHG Emission Reductions		
CalEEMod GHG Emission Reductions (Yr 1)	262.86	MT CO_2e
CalEEMod GHG Emission Reductions (Yr F)	166.88	MT CO_2e
Total CalEEMod GHG Emission Reductions	**6,446.21**	MT CO_2e

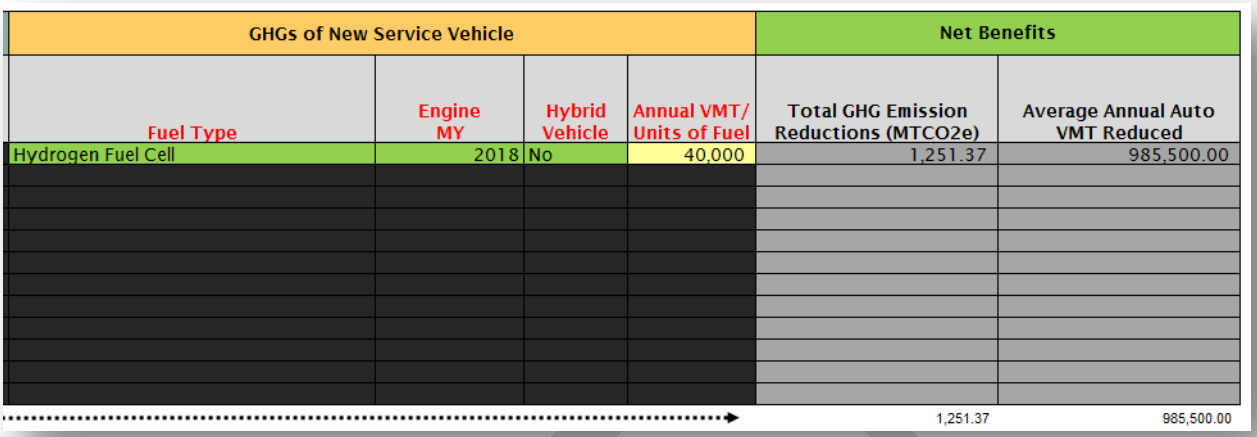
New Bus Service

To determine the Total GHG Emission Reductions from the new bus service, the applicant must use the **TAC Methods** tab in the calculator.

Go to the **TAC Inputs** tab and enter "New Bus Service (local bus)"; the fields that need to be inputted will turn yellow or green. Enter the following information according to the project's features: County, Year 1, Year F, Annual Days of Operation, Yr 1 Daily Ridership, and Yr F Daily Ridership (equal to Yr 1 Daily Ridership unless more detailed project information is available). The proposed project consists of two hydrogen-fuel buses that would each operate 2019-2022; therefore, the information for both buses may be entered in a single row. If there were any differences, such as a different Year 1 or fuel type, each bus would be entered on a separate line. The information, such as ridership and VMT, would be specific to the new or expanded service within each row.

Project Details							
Transit and Connectivity Method	County	Year 1 (Yr 1)	Year F (Yr F)	Annual Days of Operation (D)	Yr 1 Daily Ridership (R)	Yr F Daily Ridership (R)	Adjustment factor (A)
New Bus Service (local bus)	San Diego	2019	2022	365	500	500	
Total TAC Methods GHG Emission Reductions							

Scroll to the right to enter additional information: Fuel Type of the new bus service, Engine Model Year, and Annual VMT of the new bus service. The calculator will automatically provide the Total GHG Emission Reductions and Average Annual Auto VMT reductions.



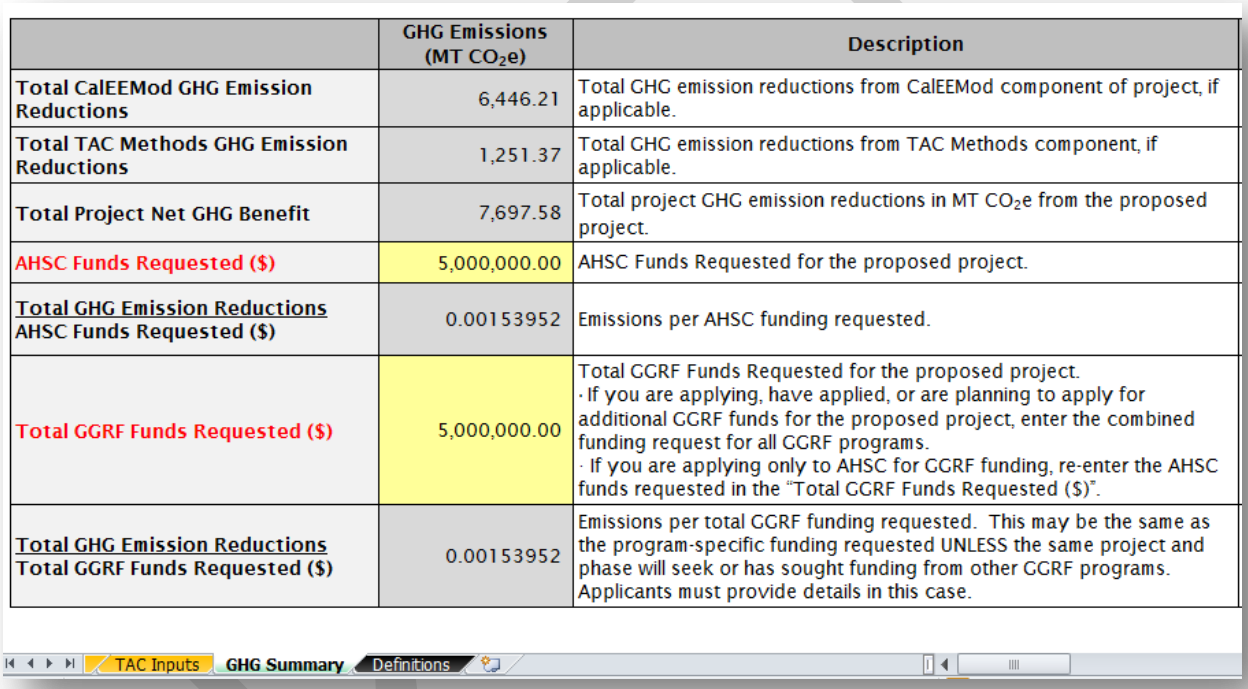
GHGs of New Service Vehicle				Net Benefits	
Fuel Type	Engine MY	Hybrid Vehicle	Annual VMT/ Units of Fuel	Total GHG Emission Reductions (MTCO2e)	Average Annual Auto VMT Reduced
Hydrogen Fuel Cell	2018	No	40,000	1,251.37	985,500.00
				1,251.37	985,500.00

Information for Documentation

The applicant should proceed to the **GHG Summary** tab and enter the Total AHSC Funds Requested and the Total GGRF Funds Requested to determine the Total GHG Emission Reductions per AHSC and GGRF Funds Requested, which are required documentation components.

Total GHG Emission Reductions are automatically calculated from the **CalEEMod Steps 4—6** tab and **TAC Inputs** tab.

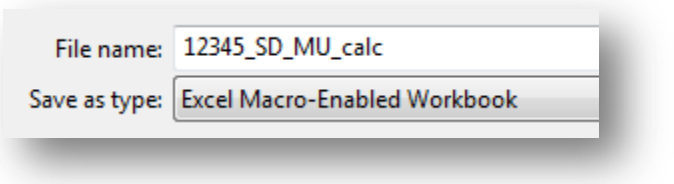
The AHSC funds requested may equal the Total GGRF funds requested if the applicant has not and does not plan to request funds for the same project and phase from other GGRF programs. In this case, applicants should enter the same dollar amount into both fields.



	GHG Emissions ($MT CO_2e$)	Description
Total CalEEMod GHG Emission Reductions	6,446.21	Total GHG emission reductions from CalEEMod component of project, if applicable.
Total TAC Methods GHG Emission Reductions	1,251.37	Total GHG emission reductions from TAC Methods component, if applicable.
Total Project Net GHG Benefit	7,697.58	Total project GHG emission reductions in MT CO_2e from the proposed project.
AHSC Funds Requested ($)	5,000,000.00	AHSC Funds Requested for the proposed project.
Total GHG Emission Reductions AHSC Funds Requested ($)	0.00153952	Emissions per AHSC funding requested.
Total GGRF Funds Requested ($)	5,000,000.00	Total GGRF Funds Requested for the proposed project. · If you are applying, have applied, or are planning to apply for additional GGRF funds for the proposed project, enter the combined funding request for all GGRF programs. · If you are applying only to AHSC for GGRF funding, re-enter the AHSC funds requested in the "Total GGRF Funds Requested ($)".
Total GHG Emission Reductions Total GGRF Funds Requested ($)	0.00153952	Emissions per total GGRF funding requested. This may be the same as the program-specific funding requested UNLESS the same project and phase will seek or has sought funding from other GGRF programs. Applicants must provide details in this case.

TAC Inputs | GHG Summary | Definitions

Save the file as instructed on the **Read Me** tab:



Applicants must submit the completed calculator along with other required documentation to SGC and ARB. Refer to Section D of the quantification methodology and the AHSC Program Application for additional requirements.

Appendix B. Land Use Subtypes and Default Parking Rates

Residential Land Use Subtypes and Parking Rates

Applicants must select the residential land use subtype that most accurately reflects the type of development proposed in the application. For example, a senior housing project would most appropriately be classified as "Retirement Community." Table B-1 provides descriptions for the most common residential land use types. Definitions were derived using the CalEEmod User's Guide. For applicants using PDT-1, default ITE parking rates are also provided in Table B-1 and were derived from ITE Parking Generation, 4th Edition, Average Peak Period Parking Demand and the percent reduction should be calculated using only the residential land use information.

Table B-1. Residential Land Use Subtype Descriptions and Default Parking Rates

Residential Land Use Subtype	Description	ITE Default Parking Rates (spaces per dwelling unit)
Single Family Housing	All single-family detached homes on individual lots.	1.83
Apartments High Rise	High-rise apartments are units located in rental buildings that have more than 10 levels and most likely have one or more elevators.	1.37
Apartments Low Rise	Low-rise apartments are units located in rental buildings that have 1-2 levels.	1.23
Apartments Mid Rise	Mid-rise apartments in rental buildings that have between 3 and 10 levels.	Apartments with three or four stories should use 1.23; apartments with five to 10 stories should use 1.37
Condo/Townhouse	Ownership units that have at least one other owned unit within the same building structure.	1.38
Condo/Townhouse High Rise	Ownership units that have three or more levels.	1.38
Retirement Community	Communities that provide multiple elements of senior adult living.	0.59

Non-Residential Land Use Subtypes and Parking Rates

For the non-residential component of mixed-use projects, the applicant must use a land use type of "Commercial" and a land use subtype of "General Office Building." PDT-1 only applies to residential land uses; therfore, no parking rate information is needed for non-residenical land use subtypes.

Appendix C. Project Setting Types

Applicants should use the descriptions in the table below, as defined in the CAPCOA Quantification Report, to determine the appropriate Project Setting. The descriptions provide the typical characteristics of the Project Setting types used by CAPCOA and in CalEEMod for determining the effectiveness of strategies for reducing VMT. The maximum reduction values are derived from the percentage difference in per capita VMT compared against a statewide average and reflect the highest reduction levels justified by the literature as reviewed for the CAPCOA Quantification Report. TOD and ICP Project Type applicants must provide a narrative explaining the justification for the Project Setting used. RIPA Project Type applicants are required to use Low Density Suburban and therefore do not have to submit a narrative.

CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Urban	Urban	A project located within the central city and may be characterized by multi-family housing, located near office and retail. The urban locations listed above have the following characteristics: o Location relative to the regional core: these locations are within the CBD or less than five miles from the CBD (downtown Oakland and downtown San Francisco). o Ratio or relationship between jobs and housing: jobs-rich (jobs/housing ratio greater than 1.5) o Density character • typical building heights in stories: six stories or (much) higher • typical street pattern: grid • typical setbacks: minimal • parking supply: constrained on and off street • parking prices: high to the highest in the region o Transit availability: high quality rail service and/or comprehensive bus service at 10 minute headways or less in peak hours Examples: San Francisco, Downtown Oakland	75%

CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Urban Center	Compact Infill	A project located on an existing site within the central city or inner-ring suburb with high-frequency transit service. Examples may be community redevelopment areas, reusing abandoned sites, intensification of land use at established transit stations, or converting underutilized or older industrial buildings. The compact infill locations listed above have the following characteristics: o Location relative to the regional core: these locations are typically 5 to 15 miles outside a regional CBD o Ratio or relationship between jobs and housing: balanced (jobs/housing ratio ranging from 0.9 to 1.2) o Density character • typical building heights in stories: two to four stories • typical street pattern: grid • typical setbacks: 0 to 20 feet • parking supply: constrained • parking prices: low to moderate o Transit availability: rail service within two miles, or bus service at 15 minute peak headways or less Examples: Fairfax (LA), Albany	40%

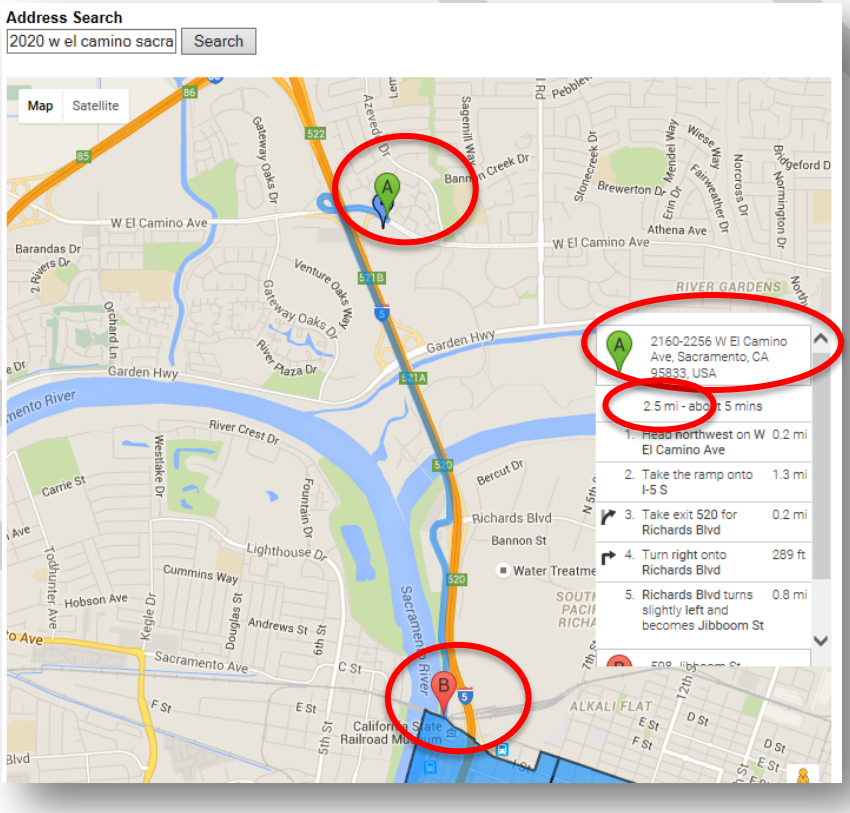
CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Suburban Center	Suburban Center	A project typically involving a cluster of multi-use development within dispersed, low-density, automobile dependent land use patterns (a suburb). The center may be an historic downtown of a smaller community that has become surrounded by its region's suburban growth pattern in the latter half of the 20th Century. The suburban center locations listed above have the following characteristics: o Location relative to the regional core: these locations are typically 20 miles or more from a regional CBD o Ratio or relationship between jobs and housing: balanced o Density character • typical building heights in stories: two stories • typical street pattern: grid • typical setbacks: 0 to 20 feet • parking supply: somewhat constrained on street; typically ample off-street • parking prices: low (if priced at all) o Transit availability: bus service at 20-30 minute headways and/or a commuter rail station Examples: Downtown San Rafael, San Mateo	20%

CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Low Density Suburban	Suburban	A project characterized by dispersed, low-density, single-use, automobile dependent land use patterns, usually outside of the central city (a suburb). Suburbs typically have the following characteristics: o Location relative to the regional core: these locations are typically 20 miles or more from a regional CBD o Ratio or relationship between jobs and housing: jobs poor o Density character • typical building heights in stories: one to two stories • typical street pattern: curvilinear (cul-de-sac based) • typical setbacks: parking is generally placed between the street and office or retail buildings; large-lot residential is common • parking supply: ample, largely surface lot-based • parking prices: none o Transit availability: limited bus service, with peak headways 30 minutes or more Examples: Areas that don't fit into one of the other definitions	15%

Appendix D. Distance to Central Business District

The distance from a project to a central business district (CBD) is used in Section B. GHG Quantification Methodology Using CalEEMod for LUT-4 and as one of the criteria in selecting a Project Setting type (see Appendix C). CBD is defined as census tract (using 2011 census data) with at least 5,000 jobs per square mile. To determine the distance to CBD for a project, applicants will use the following webpage, which includes instructions:
http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/kml/jobcentermap.html.

Applicants are instructed to submit a screenshot of the map that includes the "from" and "to" pins, the project address, and the project distance to CBD. An example screenshot with the required elements circled is shown below. In this example, the distance from the project to CBD is 2.5 miles. This value would be used in CalEEMOD for LUT-4, if applicable and for determining the appropriate Project Setting in Appendix C.



Appendix E. Equations Supporting the AHSC GHG Calculator Tool

ARB developed the Excel-based AHSC GHG Calculator tool to automate many of the portions of this quantification methodology. This appendix provides the equations used in the AHSC GHG calculator.

CalEEMod Methods—Additional Benefits and GHG Calculations

Calculations supporting Section B steps 4 through 6 are provided below.

Step 4: Calculate Additional Benefits

The following equations support these measures:

A. LUT-1: Increase Density
B. SDT-2: Provide Traffic Calming Measures
C. TRT-4(residents): Transit Subsidy for Residents. Note: The CalEEMod Transit Subsidy is applicable to non-residential land use types (for employees). This equation has been provided to apply transit subsidies to residents.

A. Increase Density (LUT-1)

$$\%\ Density\ Increase = 100 * \left[\frac{Project\ dwelling\ units\ per\ acre - Net\ Density}{Net\ Density}\right] \quad \textbf{(Eq. 1)}$$

$$\%\ VMT\ Reduction = 0.07 * \%\ Density\ Increase \quad \textbf{(Eq. 2)}$$

or 30% (whichever is lower)

Where,
Net Density is the minimum net density requirements as defined in the AHSC Guidelines by project location shown in Table E-1.

Table E-1. Net Density Lookup Table for Eq. 2

CalEEMod Project Setting Types	AHSC Guideline Requirements	
	Project Location	Minimum Net Density
Urban and Urban Center	Urban	30 du/ acre
Suburban Center	Suburban	20 du/acre
Low Density Suburban	Non-Metropolitan	15 du/acre

B. Provide Traffic Calming Measures (SDT-2)

$$\%\, VMT\ Reduction = 1\% \quad \textbf{(Eq. 3)}$$

C. Transit Subsidy for Residents (TRT-4(residents))

$$\%\, VMT\ Reduction = A * B * \left(\frac{C}{30}\right) \quad \textbf{(Eq. 4)}$$

Where,
A is the percent VMT reduction per eligible resident shown in Table E-2.

Table E-2. Adjustment Factor (A) Lookup Table for Eq. 4

Transit Subsidy or Discount per Year per Eligible Resident	A=Percent Reduction in Commute VMT per Eligible Resident		
	Low Density Suburban[1]	Suburban Center[35]	Urban and Urban Center[35]
From $273.75 to $543.84	1.5%	3.4%	6.2%
$543.85 to $1,087.69	3.3%	7.3%	12.9%
$1,087.70 to $2,175.39	7.9%	16.4%	20.0%
$2,175.40 or greater	20.0%	20.0%	20.0%

Note: Subsidies below $273.75 per Eligible Resident per Year may not use this measure.

B is the percent of residents eligible for the subsidized or discounted transit program (i.e., 0-100).

C is the number of years that the subsidy/discount is funded or guaranteed under the proposed project or transit agency program (i.e., 0-30 years).[2]

Example: A project providing a $2,500 per year subsidy to 100% of residents for 3 years would calculate the % VMT reduction as: % VMT reduction = [20% * 100 * (3/30)] = 2%.

[1] Refer to Project Setting designation used from Table 2.
[2] The subsidy/discount may include GGRF and other enforceable commitment funds.

Step 5: Calculate the CalEEMod Annual VMT Reductions

Annual VMT reductions

$$Additional\ \%\ VMT\ Reductions = Eq.2 + Eq.3 + Eq.4 \quad \textbf{(Eq. 5)}$$

$$Additional\ VMT\ Reductions = Unmitigated\ VMT * Additional\ \%\ VMT\ Reductions \quad \textbf{(Eq. 6)}$$

$$Total\ Annual\ VMT\ Reductions = Unmitigated\ VMT - Mitigated\ VMT + Additional\ VMT\ Reductions\ (Eq.5) \quad \textbf{(Eq. 7)}$$

Percent VMT Reductions for the project

$$Percent\ VMT\ Reduction = \frac{Total\ Annual\ VMT\ Reductions}{Unmitigated\ VMT} \quad \textbf{(Eq. 8)}$$

The project Maximum Potential Reductions according to the Project Setting is shown in Table E-3.

Table E-3. Maximum Potential Reductions by Project Setting Type

CalEEMod Project Setting Types*	Maximum Potential Reductions (Total maximum project VMT reduction)[3]
Low Density Suburban	15%
Suburban Center	20%
Urban Center	40%
Urban	75%

*Listed in order of increasing maximum potential reductions

If the Percent VMT Reduction is greater than the Maximum Potential Reduction for the Project Setting, **Adjust** the Percent VMT Reduction:

$$Adjusted\ Percent\ VMT\ Reduction = Maxiumum\ Potential\ Reduction\ by\ Project\ Setting \quad \textbf{(Eq. 9)}$$

Annual CalEEMod VMT Reductions

$$Annual\ CalEEmod\ VMT\ Reductions = (Adjusted)Percent\ VMT\ Reduction * Unmitigated\ VMT \quad \textbf{(Eq. 10)}$$

[3] As defined in the CAPCOA Quantification Report. The interactions among transportation-related measures are complex and sometimes counter-intuitive. The maximum reduction values are derived from the percentage difference in per capita VMT compared against a statewide average and reflect the highest reduction levels justified by the literature as reviewed for the CAPCOA Quantification Report.

Step 6: Calculate the Total CalEEMod GHG Emission Reductions

CalEEMod GHG Emission Reductions for Year 1 and Year F:

$$CalEEmod\ Reductions\ (Yr\ 1) = \frac{Annual\ CalEEMod\ VMT\ Reductions * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 11)}$$

$$CalEEmod\ Reductions\ (Yr\ F) = \frac{Annual\ CalEEMod\ VMT\ Reductions * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 12)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile) by county for Year 1 or Year F. The life of the project is defined as 30 years; therefore, Year F = Year 1 + 30. Emission factor lookup tables are provided in the links in Table F-1. Appendix F provides the methodology for the emission factor development.

Total CalEEMod GHG Reductions:

$$CalEEmod\ Reductions = \frac{CalEEMod\ Reductions_{Yr\ 1} + CalEEMod\ Reductions_{Yr\ F}}{2} * 30 \quad \textbf{(Eq. 13)}$$

TAC Methods—Additional Benefits and GHG Calculations

Calculations supporting the TAC Methods are provided below.

New/Expanded Bus, Train, Shuttle, or Vanpool Service

Annual VMT of Displaced Autos from New/Expanded Service

$$Annual\ Auto\ VMT\ Reduced\ from\ New/Expanded\ Service\ = D * R * A * L \quad \textbf{(Eq. 14)}$$

Where,

Factor	Description	Default Values			
		Bus	**Train[4]**	**Shuttle**	**Vanpool**
D	Days of operation per year	260 (weekday service) 365 (daily service)	User-defined	260 (weekday service) 365 (daily service)	260 (weekday service) 365 (daily service)
R	Change in Daily ridership	Expected daily ridership based on project data. For example, one bus rider commuting round trip per day is two bus trips per day.*			
A	Adjustment factor to account for transit dependency	0.5 (local bus) 0.83 (long distance commuter)	User-defined	0.83	0.83
L	Length of average auto trip reduced	10.8 miles[5]	User-defined	16	35

*If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT reduced for the first and last year of the project operation.

[4] Default values for new Train service are not available due to high variability. Applicants must provide these values and document how the values were derived.
[5] Average statewide trip length, per CalEEMod.

Auto GHG Reductions for Year 1 and Year F of the New/Expanded Service

$$Auto\ GHG\ Reductions\ (Yr\ 1) = \frac{(Annual\ VMT\ Reduced_{Yr\ 1}) * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 15)}$$

$$Auto\ GHG\ Reductions\ (Yr\ F) = \frac{(Annual\ VMT\ Reduced_{Yr\ F}) * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 16)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile); found in the Lookup table links in Table F-1.

New/Expanded Service Auto GHG Useful Life (UL) Emission Reductions

$$Auto\ UL\ Emission\ Reductions = \frac{Auto\ Reductions_{Yr1} + Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq.17)}$$

Where,
UL is Useful Life, as defined as the number of years the project has enforceable committed funds for operation of the new/expanded service.

New/Expanded Service GHG Emissions for Year 1 and Year F

$$Service\ Emissions\ (Yr\ 1) = \frac{(SVMT_{Yr\ 1}) * SEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 18)}$$

$$Service\ Emissions\ (Yr\ F) = \frac{(SVMT_{Yr\ F}) * SEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 19)}$$

Where,
SVMT is the annual VMT for the New/Expanded Service; and
SEF is the Emission Factor (grams of CO_2e per mile) for the New/Expanded Service Vehicle, found in the Lookup table links in Table F-1.

New/Expanded Service GHG Useful Life (UL) Emissions

$$Service\ UL\ Emissions = \frac{Service\ Emissions_{Yr1} + Service\ Emissions_{YrF}}{2} * UL \quad \textbf{(Eq. 20)}$$

New/Expanded Service Total GHG Reductions

$$New/Expanded\ Service\ Total\ GHG\ Reductions = Auto\ UL\ Emission\ Reductions - Service\ UL\ Emissions \quad \textbf{(Eq. 21)}$$

New Ferry Service

Annual VMT of Displaced Autos from New Service

$$Annual\ Auto\ VMT\ Reduced\ from\ New\ Service\ = D * R * A * L \quad \textbf{(Eq. 22)}$$

Where,

Factor	Description
D	Days of operation per year
R	Change in daily ridership
A	Adjustment factor to account for transit dependency
L	Length of average auto trip reduced

*If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT reduced for the first and last year of the project operation. Applicant must provide these values and documentation supporting the values.

Auto GHG Reductions for Year 1 and Year F of the New/Expanded Service

$$New/Expanded\ Service\ Auto\ Reductions\ (Yr\ 1) = \frac{(Annual\ VMT\ Reduced_{Yr\ 1}) * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 23)}$$

$$New/Expanded\ Service\ Auto\ Reductions\ (Yr\ F) = \frac{(Annual\ VMT\ Reduced_{Yr\ F}) * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 24)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile); found in the Lookup table links in Table F-1.

New/Expanded Service Auto GHG Useful Life (UL) Emission Reductions

$$Auto\ UL\ Reductions = \frac{Auto\ Reductions_{Yr1}\ + Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq.25)}$$

Where,
UL is Useful Life, as defined as the number of years the project has enforceable committed funds for operation of the new/expanded service.

New/Expanded Service GHG Emissions for Year 1 and Year F

$$Service\ Emissions\ (Yr\ 1) = \frac{(Fuel\ Consumption_{Yr\ 1}) * FEF}{1{,}000{,}000} \quad \textbf{(Eq. 26)}$$

$$Service\ Emissions\ (Yr\ F) = \frac{(Fuel\ Consumption_{Yr\ F}) * FEF}{1{,}000{,}000} \quad \textbf{(Eq. 27)}$$

Where,
Fuel Consumption is the amount of fuel consumed by the Ferry per year in Year 1 or Year F;
FEF is the carbon intensity Emission Factor (grams of CO_2e per unit of fuel) for the Ferry, according the type of fuel consumed, found in Appendix F.

New/Expanded Service GHG Useful Life (UL) Emissions

$$Service\ UL\ Emissions = \frac{Service\ Emissions_{Yr\ 1} + Service\ Emissions_{Yr\ F}}{2} * UL \quad \textbf{(Eq. 28)}$$

New/Expanded Service Total GHG Reductions

$$Total\ GHG\ Reductions = Auto\ UL\ Emission\ Reductions - Service\ UL\ Emissions \quad \textbf{(Eq. 29)}$$

Capital Improvements

Annual VMT of Displaced Autos

$$Annual\ Auto\ VMT\ Reduced = D * R * A * L \quad \textbf{(Eq. 30)}$$

Where,

Factor	Description
D	Days of operation per year
R	Change in daily ridership
A	Adjustment factor to account for transit dependency
L	Length of average auto trip reduced

*If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT reduced for the first and last year of the project operation. Applicant must provide these values and documentation supporting the values.

Auto GHG Reductions for Year 1 and Year F

$$Auto\ Reductions\ (Yr\ 1) = \frac{(Annual\ VMT\ Reduced_{Yr\ 1}) * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 31)}$$

$$Auto\ Reductions\ (Yr\ F) = \frac{(Annual\ VMT\ Reduced_{Yr\ F}) * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 32)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile); found in the Lookup table links in Table F-1.

Total GHG Useful Life (UL) Reductions

$$Total\ Reductions = \frac{Auto\ Reductions_{Yr1} + Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq. 33)}$$

Where,
UL is Useful Life, as defined as the number of years the project has enforceable committed funds for operation of the new/expanded service.

Bicycle Paths, Bicycle Lane, Bikeways, or Pedestrian Facilities

Annual VMT Reductions of Displaced Autos from Bicycle Path, Bicycle Lanes, Bikeways, and Pedestrian Facilities

$$Auto\ VMT\ Reduced = (D) * (ADT) * (A + C) * (L) \quad \textbf{(Eq. 34)}$$

Where,

Factor	Description	Default Values
D	Days of use per year of new service	200
ADT	Annual Average Daily Traffic (two-way traffic volume in trips/day on parallel road. Use applicable value from project data (Maximum = 30,000)	Use project-specific data.
A	Adjustment factor to account for bike use	Use applicable value from Table E-3
C	Activity Center Credit near project	Use applicable value from Table E-4
L	Length of bicycle trip	1.8 miles per trip in one direction

Table E-3. Adjustment Factor (A) Lookup Table for Eq. 34

Average Daily Traffic (ADT)	Length of Bike Project (one direction)	A (for cities >250,000 and non-university towns <250,000)	A (for university towns with population <250,000)
ADT ≤ 12,000 vehicles per day	≤ 1 mile	.0019	.0104
	> 1 & ≤ 2 miles	.0029	.0155
	> 2 miles	.0038	.0207
12,000 < ADT ≤ 24,000 vehicles per day	≤ 1 mile	.0014	.0073
	> 1 & ≤ 2 miles	.0020	.0109
	> 2 miles	.0027	.0145
24,000 < ADT ≤ 30,000 vehicles per day Maximum is 30,000	≤ 1 mile	.0010	.0052
	> 1 & ≤ 2 miles	.0014	.0078
	> 2 miles	.0019	.0104

Table E-4. Activity Center Credit (C) Lookup Table for Eq. 34

Count your Activity Centers. If there are…	Within 1/2 mile of Project Area	Within 1/4 mile of Project Area
3	.0005	.001
More than 3 but fewer than 7	.0010	.002
7 or more	.0015	.003

Activity Center examples: Bank, church, hospital or HMO, light rail station (park & ride), office park, post office, public library, shopping area or grocery store, university, or junior college. These metrics should be evaluated for the project location site and surrounding area which can extend a distance from the housing development not to exceed one-half (½) mile.

Auto GHG Reductions for Year 1 and Year F of the Bicycle Path, Bicycle Lane, Bikeway, or Pedestrian Facility

$$Auto\ Reductions_{Yr\ 1} = \frac{Auto\ VMT\ Reduced * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 35)}$$

$$Auto\ Reductions_{Yr\ F} = \frac{Auto\ VMT\ Reduced * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 36)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile); found in the Lookup table links in Table F-1.

GHG Emission Reductions from the useful life of the Project

$$GHG\ Emission\ Reductions = \frac{Auto\ Reductions_{Yr1} + Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq. 37)}$$

Where,
UL is the useful life, which is 20 years for Class 1, 15 years for Class 2, and Class 4 bicycle lanes, and 20 years for pedestrian facilities.

Bike Share

The GHG emission reductions from Bike Share projects that result in an increase in bike trips are calculated as the GHG emission reductions from displaced autos.

$$Auto\ VMT\ Reduced = (T) * (A) * (L) \quad \textbf{(Eq. 38)}$$

Where,

Factor	Description	Default Values
T	Total number of bike trips using bike share bikes expected in the first year of Service	Use project-specific data
A	Adjustment factor to account for induced demand and non-utilitarian and/or non-commute use	Default is 0.5
L	Length of bicycle trip	1.8 miles per trip in one direction

Auto GHG Reductions for Year 1 and Year F of the bike share project

$$Auto\ Reductions_{Yr1} = \frac{Auto\ VMT\ Reduced * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 39)}$$

$$Auto\ Reductions_{YrF} = \frac{Auto\ VMT\ Reduced * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 40)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile); found in the Lookup table links in Table F-1.

GHG Emission Reductions over the useful life of the project

$$GHG\ Emission\ Reductions = \frac{Auto\ Reductions_{Yr1} + Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq. 41)}$$

Where,
UL is the useful life, which is 10 years for a bike share project**.**

Appendix F. Emission Factors

Emission Factor Lookup Tables

GGRF programs estimate transportation-related emissions using a "Well-to-Wheels" approach, which consists of emissions resulting from the production and distribution of different fuel types and any associated exhaust emissions. AHSC Program applicants use project-specific data to calculate new or avoided VMT, and VMT is converted to GHG emissions using Well-to-Wheels emission factors embedded in the AHSC GHG Calculator tool. Table F-1 provides links to the relevant Lookup tables used in the AHSC GHG Calculator by vehicle type. A detailed methodology of how the emission factors were developed is provided below.

Table F-1. Emission Factor Look Up Tables

Vehicle Type	Link to Emission Factor Lookup Tables
Auto	www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_autos_draft.pdf
Cut-A-Way	www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_cutaway_draft.pdf
Train*	www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_train_draft.pdf
Bus	www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_ubus_draft.pdf
Van	www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_van_draft.pdf

*Train lookup tables include Heavy Rail, Light Rail and Streetcar emission factors.

Ferry Emission Factors

Due to the high variability in ferries, standardized emission factors are not available for new ferry service. Emissions for ferries require project-specific information for the estimated quantity and type of fuel used annually, which are used with the appropriate carbon content factor from Table F-2 to convert fuel to GHG emissions. The same emission factor will be used for both Year 1 and Year F.

Train Emission Factors

Similar to Ferries, applicants may use project-specific information on the estimated quantity and type of fuel used annually. The same emission factor will be used for both Year 1 and Year F.

Table F-2. Fuel-Specific Factors[6]

Fuels (units)	Energy Density	Carbon Intensity	Carbon Content*
Biodiesel (gal)	126.13 (MJ/gal)	65.50 (gCO2/MJ)	8,261.64 (gCO_2e/gal)
CNG (ft^3)	1.04 (MJ/ft^3)	78.37 (gCO2/MJ)	81.28 (gCO_2e/ft^3)
Diesel (gal)	134.48 (MJ/gal)	102.01 (gCO2/MJ)	13,718.04 (gCO_2e/gal)
Electric (KWh)	3.60 (MJ/KWh)	105.15 (gCO2/MJ)	378.54 (gCO_2e/KWh)
Gas (gal)	115.83 (MJ/gal)	98.47 (gCO2/MJ)	11,405.84 (gCO_2e/gal)
Hydrogen (kg)	119.99(MJ/kg)	88.33 (gCO2/MJ)	10,598.43 (gCO_2e/kg)
LNG (gal)	78.83 (MJ/gal)	94.41 (gCO2/MJ)	7,442.70 (gCO_2e/gal)
Renewable Diesel (gal)	129.65 (MJ/gal)	43.31 (gCO2/MJ)	5,615.12 (gCO_2e/gal)
Renewable Natural Gas (ft^3)	1.04 (MJ/ft3)	18.11 (gCO2/MJ)	18.78 (gCO_2e/ft^3)

*Carbon Content Emission Factors are calculated using fuel type Energy Density (megajoule (MJ) per unit of fuel) and the fuel type Carbon Intensity (grams of CO2e per MJ).[i]

Table F-3. Energy Economy Ratios[6]

Fuels (units)	EER Values Relative to Diesel	EER Values Relative to Gas
Biodiesel (gal)	1.0	--
CNG (ft^3)	0.9	1.0
Diesel (gal)	1.0	--
Electric (KWh)	4.2 (Bus) 4.6 (Heavy Rail) 3.3 (Light Rail) 3.1 (Street Car)	3.4
Gas (gal)	0.9	1.0
Hydrogen (kg)	1.9	2.5
LNG (gal)	0.9	1.0
Renewable Diesel (gal)	1.0	--
Renewable Natural Gas (ft^3)	0.9	1.0

The emission factors were developed using fuel consumption rates from EMFAC 2014 and carbon intensity values for different fuel types from ARB's Low Carbon Fuel Standard (LCFS) Program. This approach provides consistency amongst transportation-related GGRF programs and ARB's Low Carbon Fuel Standard (LCFS)[ii] Program.

The following sections provide details on how the emission factors were developed. Some emission factors were developed using similar approaches for more than one vehicle type, therefore are included together under the same section. For example, Cut-away and Van emission factors were developed using a gasoline baseline.

Auto Vehicle Emission Factors

Passenger (auto) vehicle emission factors (**AVEF**) were derived using the following steps.

1. Emissions by county for each calendar year from 2017 through 2050 were downloaded from EMFAC 2014 with the following parameters:
    a. Annual Average
    b. EMFAC2011 vehicle categories LDA, LDT1, LDT2, and MDV
    c. Aggregated model year
    d. Aggregated speed
    e. Gasoline fuel

2. The auto fuel consumption rate (**AFCR**, in gallons of gasoline per mile) was calculated using the total gallons of gasoline used by each vehicle category divided by the total mileage by vehicle category by county and year, using Equation 42.

$$AFCR = \frac{(Fuel\_Consumption_{LDA} + Fuel\_Consumption_{LDT1} + Fuel\_Consumption_{LDT2} + Fuel\_Consumption_{MDV}) * 1{,}000}{VMT_{LDA} + VMT_{LDT1} + VMT_{LDT2} + VMT_{MDV}} \quad \textbf{(Eq. 42)}$$

Where,
Fuel Consumption is the total fuel consumption for the vehicle type, in 1,000 gallons per day, from EMFAC 2014 (gasoline gallons).
VMT is the total VMT for the vehicle type, in miles per day, from EMFAC 2014 (miles).

3. The auto vehicle emission factors (**AVEF**, in grams of CO_2e per mile) were calculated for each year and county by multiplying the auto fuel consumption rate by the Well-to-Wheels carbon content factor for gasoline, which is 11,405.84 g CO_2e per gallon (Table F-2), using Equation 43.

$$AVEF = 11{,}405.84 * AFCR \quad \textbf{(Eq. 43)}$$

Where,
11,405.84 is the Well-to-Wheels carbon content factor for gasoline (gCO2e/gallon).
AFCR is the Auto Fuel Consumption calculated in Equation 42 (gallons/mile).

Transit Bus Emission Factors

The transit bus (bus) emission factors (**BEF**) were derived using a similar method, as follows.

1. The statewide emissions each calendar year from 2017 through 2050 were downloaded from EMFAC 2014 with the following parameters:
    a. Annual Average
    b. EMFAC2011 vehicle categories UBUS
    c. All model years
    d. Aggregated speed
    e. Diesel fuel

2. The bus fuel consumption rate (**BCR**, in gallons of diesel per mile) was calculated using the total gallons of diesel fuel used by each vehicle category and model year divided by the total mileage by vehicle category and model year, using Equation 44.

$$BCR_{diesel} = \frac{Fuel\_Consumption_{(UBUS\ \ \mathbf{OR}\ MC)} \ * \ 1{,}000}{VMT_{(UBUS\ \ \mathbf{OR}\ MC)}} \quad \textbf{(Eq. 44)}$$

Where,
Fuel Consumption is the total fuel consumption for the vehicle type, in 1,000 gallons per day, from EMFAC 2014 (gasoline gallons).
VMT is the total VMT for the vehicle type, in miles per day, from EMFAC 2014 (miles).

3. Diesel emission factors were developed using data as described in (a) below. Emission factors for other fuel types convert the diesel bus fuel consumption rate to the appropriate fuel type as described in (b).
    a. Diesel: the bus emission factor (**BEF**, in grams of CO_2e per mile) for each calendar year and model year were obtained by multiplying the bus fuel consumption rate (**BCR**, in gallons per mile) by the Well-to-Wheels carbon content factor for diesel (13,718.04 g CO_2e per gallon) using Equation 45.

$$BEF = \ 13{,}718.04 * BCR \quad \textbf{(Eq. 45)}$$

Where,
F13,718.04 is the Well-to-Wheels carbon content factor for diesel (gCO2e/gallon).
BCR is the Bus Fuel Consumption Rate calculated in Equation 44 (gallons/mile).

b. Non-Diesel: For fuel types other than diesel, staff converted the diesel fuel consumption rate (**BCR**) from Step 1 to the equivalent bus emission factor (**BEF**, in grams of CO_2e per mile) using Equation 46.

$$BEF_{new\_fuel} = BCR_{diesel} * ED_{diesel} * \left(\frac{1}{ED_{new\_fuel}}\right) * \left(\frac{1}{EER}\right) * CC_{new\_fuel} \quad \textbf{(Eq. 46)}$$

Where,
BCR_{diesel} is the Bus Consumption Rate calculated in Equation 44 (gallons/mile).
ED_{diesel} is 134.48 MJ per gallon, from Table F-2 (MJ/gallon).
ED_{new_fuel} is the Energy density of the new fuel type, from Table F-2 (MJ/unit of new fuel).
EER is the Energy Economy Ratio, from Table F-3 (unitless).
CC_{new_fuel} is the Carbon Content of the new fuel type, from Table F-2 (gCO2e/unit of new fuel).

Cut-A-Way and Van Emission Factors

The alternative transit vehicle emission factors (**ATEF**) were derived using a similar method, as follows.

1. The statewide emissions each calendar year from 2017 through 2050 were downloaded from EMFAC 2014 with the following parameters:
    a. Annual Average
    b. EMFAC2011 vehicle categories LDH1 for Van and LHD2 for Cut-A-Way
    c. All model years
    d. Aggregated speed
    e. Gasoline fuel

2. The alternative transit vehicle fuel consumption rate (**ATCR**, in gallons of gasoline per mile) was calculated using the total gallons of gasoline fuel used by each vehicle category and model year divided by the total mileage by vehicle category and model year, using Equation 47.

$$ATCR_{gas} = \frac{Fuel\_Consumption_{(LDH1\ \ \boldsymbol{OR}\ LDH2)} * 1{,}000}{VMT_{(LDH1\ \ \boldsymbol{OR}\ LDH2)}} \quad \textbf{(Eq. 47)}$$

Where,
Fuel Consumption is the total fuel consumption for the vehicle type, in 1,000 gallons per day, from EMFAC 2014 (gasoline gallons).
VMT is the total VMT for the vehicle type, in miles per day, from EMFAC 2014 (miles).

3. Gasoline emission factors were developed using data as described in (a) below. Emission factors for other fuel types convert the gasoline alternative transit vehicle fuel consumption rate to the appropriate fuel type as described in (b or c).
    a. Gasoline: the alternative transit vehicle emission factor (**ATEF**, in grams of CO_2e per mile) for each calendar year and model year were obtained by multiplying the alternative transit vehicle fuel consumption rate (**ATCR**, in gallons per mile) by the Well-to-Wheels carbon content factor for gasoline (11,405.84 g CO_2e per gallon) using Equation 48.

$$ATEF_{gas} = 11{,}405.84 * ATCR \quad \textbf{(Eq. 48)}$$

Where,
11,405.84 is the Well-to-Wheels carbon content factor for gasoline (gCO2e/gallon).
ATCR is the Alternative Transit Fuel Consumption calculated in Equation 47 (gallons/mile).

    b. Non-Gasoline (non-diesel): For non-gasoline fuel types other than diesel, staff converted the gasoline fuel consumption rate (**ATCR**) from Step 2 to the equivalent alternative transit vehicle emission factor (**ATEF**, in grams of CO_2e per mile) using Equation 49.

$$ATEF_{new\_fuel} = ATCR_{gas} * ED_{gas} * \left(\frac{1}{ED_{new\_fuel}}\right) * \left(\frac{1}{EER}\right) * CC_{new\_fuel} \quad \textbf{(Eq. 49)}$$

Where,
$ATCR_{gas}$ is the Alternative Transit Vehicle Consumption Rate for gasoline, from Equation 47 (gallons/mile).
ED_{gas} is 115.83 MJ per gallon, from Table F-2 (MJ/gallon).
ED_{new_fuel} is the Energy density of the new fuel type, from Table F-2 (MJ/unit of new fuel).
EER is the Energy Economy Ratio, from Table F-3 (unitless).
CC_{new_fuel} is the Carbon Content of the new fuel type, from Table F-2 (gCO2e/unit of new fuel).

    c. Non-Gasoline (diesel): For diesel, staff converted the gasoline fuel consumption rate (**ATCR**) from Step 2 to the equivalent alternative transit vehicle emission factor (**ATEF**, in grams of CO_2e per mile) using Equation 50.

$$ATEF_{diesel} = ATCR_{gas} * EER * ED_{gas} * \left(\frac{1}{ED_{diesel}}\right) * CC_{diesel} \quad \textbf{(Eq. 50)}$$

Where,
$ATCR_{gas}$ is the Alternative Transit Vehicle Consumption Rate for gasoline calculated in Equation 47 (gallons/mile).
EER is the Energy Economy Ratio, from Table F-3 (unitless).
ED_{gas} is 115.83 MJ per gallon, from Table F-2 (MJ/gallon).
ED_{diesel} is 134.47 MJ per gallon, from Table F-2 (MJ/gallon).
CC_{new_fuel} is the Carbon Content of the new fuel type, from Table F-2 (gCO2e/unit of new fuel).

Train Emission Factors

Train emission factors were derived using the following process.

1. A Train Consumption Rate (**TCR**, in gallons of diesel per mile) was calculated using the total gallons of diesel fuel used by 130 trains across the State in 2010 divided by the total mileage of those trains using Equation 51.

$$TCR = \frac{Fuel\ Consumption}{VMT} \quad \textbf{(Eq. 51)}$$

Where,
Fuel Consumption is the total fuel consumption for 130 trains (gallon).
VMT is the total mileage from 130 trains (miles).

2. The diesel emission factor was developed using data as described in (a) below. Emission factors for other fuel types convert the diesel new service fuel consumption rate to the appropriate fuel type as described in (b).
    a. Diesel: the train emission factor (**TEF**, in grams of CO_2e per mile) was obtained by multiplying the train fuel consumption rate (**TCR**, in gallons per mile) by the Well-to-Wheels carbon content factor for diesel (13,718.04 g CO_2e per gallon) using Equation 52.

$$TDEF = 13{,}718.04 * TCR \quad \textbf{(Eq. 52)}$$

Where,
13,718.04 is the Well-to-Wheels carbon content factor for diesel (gCO2e/gallon).
TCR is the Train Fuel Consumption calculated in Equation 51 (gallons/mile).

b. Non-Diesel: For fuel types other than diesel, staff converted the diesel fuel consumption rate (**TCR**) from Step 2 to the equivalent new service emission factor (**TEF**, in grams of CO_2e per mile) using Equation 53.

$$TEF_{new\_fuel} = TCR_{diesel} * ED_{diesel} * \left(\frac{1}{ED_{new\_fuel}}\right) * \left(\frac{1}{EER}\right) * CC_{new\_fuel} \quad \textbf{(Eq. 53)}$$

Where,
TCR_{diesel} is the Train Consumption Rate calculated in Equation 51 (gallons/mile).
ED_{diesel} is 134.48 MJ per gallon, from Table F-2 (MJ/gallon).
ED_{new_fuel} is the Energy density of the new fuel type, from Table F-2 (MJ/unit of new fuel).
EER is the Energy Economy Ratio, from Table F-3 (unitless).
CC_{new_fuel} is the Carbon Content of the new fuel type, from Table F-2 (gCO2e/unit of new fuel).

[i] Low Carbon Fuel Standard Program Regulation
https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf
[ii] https://www.arb.ca.gov/fuels/lcfs/lcfs.htm